AD-A260 578

AD

4

DEVELOPMENT OF A METHOD TO DETERMINE THE AUTOXIDATION OF TURBINE FUELS

FINAL REPORT
BFLRF No. 280

By

G.E. Fodor
D.W. Naegeli
Belvoir Fuels and Lubricants Research Facility (SwRI)
Southwest Research Institute
San Antonio, Texas

Under Contract to

U.S. Naval Research Laboratory
4555 Overlook Avenue, SW
Washington, DC

and

U.S. Naval Air Warfare Center
1440 Parkway Avenue
Trenton, New Jersey

Contract No. N00014-87-K-2057

Approved for public release; distribution unlimited

May 1992

Disclaimers

The findings in this report are not to be construed as an official Department of the Defense or Department of the Navy position unless so designated by authorized documents.

Trade names cited in this report do not constitute an official endorsement or approval of the use of such commercial hardware or software.

DTIC Availability Notice

Qualified requestors may obtain copies of this report from the Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22314.

Disposition Instructions

Destroy this report when no longer needed. Do not return it to the originator.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY N/A 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Interim Report BFLRF No. 280	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Belvoir Fuels & Lubricants Research Facility 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Naval Research Laboratory
6c. ADDRESS (City, State, and ZIP Code) Southwest Research Institute 6220 Culebra Road San Antonio, Texas 78238-5516	7b. ADDRESS (City, State, and ZIP Code) 4555 Overlook Ave, SW Washington, DC 20375
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Naval Air Warfare Center, Aircraft Div. 8b. OFFICE SYMBOL (If applicable) PE-33	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00014-87-K-2057
8c. ADDRESS (City, State, and ZIP Code) 1440 Parkway Avenue Trenton, New Jersey 08628	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Development of a Method to Determine The Autoxidation of Turbine Fuels (U)

12. PERSONAL AUTHOR(S)
Fodor, George E. and Naegeli, David W.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM Sept 87 TO Apr 92	1992 May	257

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Autoxidation, Peroxide, Hydroperoxide, Reaction Kinetics, Rate Constant, Induction Period, Potential Peroxide Formation, Antioxidant

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The report describes the development of a research grade test method that allows the precise evaluation of antioxidants and prediction of the rate of peroxide formation at ambient conditions from data obtained from accelerated oxidation experiments at elevated temperatures. The rates of peroxide formation in 10 model jet fuels were measured at several temperatures ranging from 43° to 120°C, with oxygen partial pressures ranging from approximately 10 to 1140 kPa. Results of rigorously controlled experiments agreed with a kinetic model of the autoxidation process, which showed that the peroxide concentration increased as the square of stress duration. Within the experimental limits, the rate of peroxide formation did not depend on the oxygen partial pressure. Arrhenius correlations of global rate constants determined from peroxide concentration time histories in accordance with the kinetic model showed that a single autoxidation was accountable for the results obtained in the 43° to 120°C temperature range.

(Continued)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. R.A. Kamin	22b. TELEPHONE (Include Area Code) (609) 538-6521 / 22c. OFFICE SYMBOL PE-33

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. ABSTRACT

This method has also been used to evaluate the effectiveness of several hindered phenolic antioxidants to inhibit the formation of peroxides in two jet fuels at temperatures of 100° and 120°C and an oxygen partial pressure of 240 kPa (ca 20 psig). Antioxidants were evaluated in terms of induction period duration and their rates of peroxide formation during the induction period and the initial linear segment of the post-induction time. The global rate constant for the formation of peroxides during the induction period was reduced by the antioxidant, whereas the post-induction rate remained unchanged. The antioxidants varied considerably in their potentials to inhibit peroxide formation; they increased the induction period of one of the test fuels to a much greater extent than the other.

EXECUTIVE SUMMARY

Objectives: Develop a practical, timely analytical chemical method to determine the peroxidation potential of turbine fuels. A further objective of this work was to demonstrate that this same analytical method is useful in evaluating the effectiveness of antioxidants in jet fuels.

Importance of Project: Based on theoretical and practical considerations, significant advances were made in the science of fuel stability, leading to a precise and timely experimental method to determine peroxidation potential of turbine fuels and to evaluate the effectiveness of antioxidants in turbine fuels.

Military Impact: Peroxides in turbine fuels caused fuel pump failures in jet aircraft. Knowledge of peroxidation potential of turbine fuels would allow steps to be taken to significantly decrease aircraft failures, thus saving both lives and equipment. The described method is the tool of choice to evaluate the storage life of turbine fuels in long-term storage, such as in strategic reserves.

Accomplishments: Using a rather large experimental matrix, 10 additive-free turbine fuels were oxidized under varied conditions to develop a method to predict the peroxidation potential of turbine fuels and to evaluate the effectiveness of antioxidants. The experimental conditions included autoxidations under air at atmospheric pressure and under pure oxygen at several pressures ranging between 240 and 1140 kPa. The reactions were performed at six temperatures between 43° and 120°C. Except for the tests conducted using air at atmospheric pressure, the experiments were carried out using pure oxygen in unvented stirred stainless steel reactors. The oxygen pressure in the vapor phase was regulated, and the temperature was maintained within ±0.5°C. Special provisions were made to maximize control over the experimental conditions, e.g., to exclude contamination of the test fuel by components of other fuels and to exclude the possibility of altering the composition of the test fuel by uncontrolled evaporation, common elements of most other similar procedures.

Within the experimental constraints, the data indicate that

- At any applied reaction temperature, the square root of the formed peroxide concentration is proportional to the oxidative stress duration;
- The average coefficient of determination, R^2, at 100°C for all induction periods, i.e., the neat fuels and the antioxidant-doped fuels, is 0.908. The corresponding coefficient of determination for the post-induction periods is 0.966. At 120°C, the corresponding average R^2 for all the fuels, during the induction periods, is 0.940 and 0.988 for the corresponding post-induction periods;
- The measured peroxidation rates were independent of oxygen concentration while the oxygen partial pressure was above 20 kPa;
- Arrhenius correlations of the global rate constants for peroxide formation in the studied fuels gave no evidence for a change in the oxidation mechanism in the 43° to 120°C temperature range;
- Since the activation energy of peroxidation was not identical for all turbine fuels, rates of peroxide formation at ambient conditions may be predicted only if measurements are made at two or more elevated temperatures;

- As most base fuels gave rise to an induction period of oxidation, it is proposed that several of the examined fuels in the course of this study contained unidentified natural antioxidant(s), which caused an induction period in the oxidation process.

In all cases studied, chemical kinetics conclusions reached using antioxidant-free base fuels were also supported by data obtained using antioxidant-doped fuels.

Linear regression analysis of data obtained during the experimental runs gave excellent agreement with presented theory, and the derived standard deviation, coefficient of variation (relative standard deviation), and coefficient of determination, R^2, all provided excellent values, apparently limited mainly by the limits of the iodometric titrations for peroxides, as described in ASTM D 3703.

Temperature control of the reaction was found to be critical to obtain reproducible, credible data. While no detailed study was conducted to define temperature tolerance limits in these experiments, indications are that temperature should be held constant to within $\pm$ 0.5°C. This finding was not a surprise, but a natural minimum requirement of any measurements in chemical kinetics.

The 13 hindered phenolic antioxidants tested in the two turbine fuels led to essentially coinciding ranking of the products at 100° and 120°C.

As expected, the more highly hindered phenols proved to be more efficient oxidation inhibitors in the turbine fuels examined.

Evaluation of the more efficient antioxidants required about 120 to 150 hours at 100°C, but only 25 to 40 hours at 120°C.

Antioxidant responses of the two base fuels were vastly different. Based on limited experiments performed on two test fuels, hydrocarbon-type analysis suggests that the effectiveness of antioxidants is reduced by increased aromatic hydrocarbon content in the base fuel. It is probable that the higher stability of the additive-free fuel 18496 is due to its higher normal-paraffin concentration in comparison to that of fuel 18497. The higher level of antioxidant effectiveness, i.e., inhibition, of fuel 18497, as opposed to fuel 18496, may be due to inhibiting reactions at the more abundant allylic positions in fuel 18497. Further, the higher concentrations of cycloparaffins (more reactive than normal paraffins) of fuel 18497 may also contribute to this behavior.

It is strongly recommended that this research-grade analytical tool be modified to be easier to use for routine testing and evaluations. This work should be followed by full cooperative evaluation of the methodology in a round-robin type procedure prior to its adaption as a standard analytical method of choice for (a) estimation of storage stability of turbine fuels, (b) for the evaluation of antioxidants, and (c) for the determination of the effectiveness of antioxidants in turbine fuels.

FOREWORD/ACKNOWLEDGEMENTS

This work was conducted at the Belvoir Fuels and Lubricants Research Facility (BFLRF) located at Southwest Research Institute (SwRI), San Antonio, TX, for the Naval Research Laboratory (NRL) under Contract No. N00014-87-K-2057. For completeness, this report includes the results of earlier work funded by the Naval Air Propulsion Center (NAPC). NAPC funding for the earlier work was provided by a Military Interdepartmental Purchase Requisition through the U.S. Army Belvoir Research, Development and Engineering Center (Belvoir RDE Center) under Contract DAAK70-85-C-0007, with Mr. F.W. Schaekel serving as contracting officer's representative. The project monitors for the Navy were Dr. D.R. Hardy of NRL and Mr. C.J. Nowack, Mr. G.E. Speck, and Ms. L.C. Turner of NAPC.

The authors also gratefully acknowledge the invaluable participation of Ms. M.S. Voigt, Messrs. D.L. Present, K.B. Jones, and J.J. Dozier. Editorial assistance provided by Mr. J.W. Pryor and Mses. L.A. Pierce and E.F. Cantu is also acknowledged with appreciation.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT'D)

LIST OF TABLES

LIST OF TABLES (CONT'D)

I. INTRODUCTION

The need for a method of predicting the potential formation of peroxides in turbine fuels arose from fuel pump failures in jet aircraft. Shertzer (1)*, Hazlett, et al. (2), and Love, et al. (3) found that peroxides cause significant deterioration of neoprene, nitrile rubber, and Buna-N diaphragms and O-rings used in aircraft engine fuel pumps.

To avoid future problems, a program was initiated to study the kinetics of peroxide formation and ultimately to develop a timely method of predicting the peroxidation potential of jet fuels.(4-11) Several test methods have been developed to determine the oxidative stability of fuels, e.g., ASTM D 2274 (12) and ASTM D 4625 (13); they are carried out at elevated temperatures to reduce test duration. However, the most widely accepted procedure, conducted at 43°C, ASTM D 4625, requires reaction times of 3 months or longer. An accelerated, higher temperature test is desired for a timely determination of peroxidation potential of jet fuels.

The preliminary objective of this study was to establish the basic theoretical and experimental feasibility of the concept of developing a practical predictive analytical chemical methodology to determine the peroxidation potential of turbine fuels. The study included examination of the reaction mechanism of hydrocarbon autoxidation to ascertain (a) if the overall reaction mechanism remains essentially unchanged between room temperature and at such an elevated temperature that would allow the reactions to proceed at a practical rate, and (b) if the activation energy of autoxidation is the same for all turbine fuels. A further objective of this work was to demonstrate that this same analytical method would be useful to evaluate the effectiveness of antioxidants in jet fuels.

II. TEST FUELS

The test fuels (4,5) selected for this study are described in TABLE 1. Fuel 0464 was a straight-run, salt-dried, clay-treated, and additive-free kerosene; it was chosen to serve as a pristine fuel

* Underscored numbers in parentheses refer to the list of references at the end of this report.

of high oxidative stability. Four hydrocracked kerosenes were selected as potentially unstable fuels. Fuel 11310, which contained about 400 ppm of peroxides when it was received, was percolated through alumina before use to remove the existing peroxides and other possible polar compounds. This treated fuel was designated as fuel 11310A. Another hydrocracked kerosene, fuel 11381, was received with negligible peroxide content so it was not altered before use in the experiments. Two fuels received from the Naval Research Laboratory and designated as fuels AV-284 and AV-285 were part of the fuel matrix used in the third Coordinating Research Council (CRC) cooperative test program on hydroperoxide potential of jet fuels.(14) The remaining fuels were procured from commercial sources. Pure hydrocarbons were used as model compounds in preliminary experiments.

All test fuels were claimed by the source refineries to be free of added antioxidants. Infrared spectra of the polar fractions of the fuels did not detect any substituted phenols or amine-type compounds in excess of 5 ppm, the detectability limit of the procedure.

The fuels were purged with argon and stored in sealed containers at 5°C prior to their use in the accelerated oxidation experiments.

III. EXPERIMENTAL

The basic goal of this study was to determine the possibility of predicting the slow formation of peroxides in jet fuels at ambient conditions from experimental data of the relatively fast oxidation at higher temperatures. Rates of peroxide formation were measured in 10 uninhibited turbine fuels over the temperature range between 43° to 120°C, and the partial pressures of oxygen were varied from about 20 to 1140 kPa, as summarized in TABLE 2. Preliminary experiments carried out at 100°C in the stirred reactor showed that, within a 24-hour period, the peroxide formation in fuels 11310, 11310A, and 11381 was substantial. On this basis, it was concluded that rates of peroxide formation measured in the 100° to 120°C temperature range would be appropriate for predicting rates of peroxide formation at ambient conditions if the mechanism could be assumed to remain unchanged throughout the temperature range from ambient to 120°C.

To establish baseline data on the long-term stability of turbine fuels, a modified version of the ASTM D 4625 method of bottle storage at 43°C was used.(13) The modified procedure ensured that the autoxidation reactions will not become oxygen concentration limited, and that full compositional integrity of the fuel samples would be preserved. In the revised procedure, each fuel sample was purged through a fritted tip glass bubbler with "synthetic" bottled air (21 vol% O_2 and 79 vol% N_2) at a rate of 300 mL/min until the fuel became saturated with oxygen, as determined by gas chromatography. Depending upon the identity of the fuel, the time required to achieve equilibrium oxygen concentration in the liquid phase varied between 5 and 20 minutes. Due to this variability, the aeration and replenishment procedures were standardized to use an air saturation time of 20 minutes with each fuel sample.

The aerated fuel samples were sealed in amber borosilicate bottles to retain full sample integrity during the long-term storage periods. Then the fuel samples were stored at 43°C in a convection oven. The oxygen contents were determined periodically by gas chromatography in both the liquid and vapor phases by analyzing samples drawn from the closed bottles through perfluoroethylene septa in the bottle caps. When oxygen concentration in the vapor phase dropped below 10.0 vol%, the remaining bottles of the same fuel were again aerated at room temperature. This modification of the published procedure was found necessary to detect and correct for possible depletion of oxygen in the bottled fuels. Such oxygen depletion was of special concern in the case of the more reactive fuels, where it could have had significant effect on the rate of peroxide formation.

After scheduled aging periods, one bottle of each fuel was retrieved for analysis of peroxides (ASTM D 3703), gum (ASTM D 381), water (ASTM D 1744), and acid number (ASTM D 664).

The procedure described by Hall (15) was used for bottle storage experiments at 65°C. This protocol was basically the same as that used in the 43°C experiments, except that, in the relatively short-term 65°C experiments, as required by Hall's memo, the samples were only aerated by opening the bottles to room air for about 15 minutes weekly.

Accelerated oxidative stressing of the test fuels at temperatures above 65°C were carried out in replicate in two nominally identical 600-mL, Type 316 stainless steel stirred pressure reactors (Modified PARR Mini Reactors, No. 4573). Temperature was regulated to ± 0.5°C, and the oxygen pressure was maintained at a minimum of 240 kPa (20 psig), as set at 23°C, and was continuously monitored. The schematic and a photograph of the reactors are shown in the Appendix.

The reactors were each charged with 300 mL of fuel and purged with ultrahigh-purity oxygen (99.99 percent); they were then pressurized with the ultrapure oxygen and heated to the desired test temperature. The fuel was stirred at 150 rpm to ensure rapid dissolution of oxygen and to prevent temperature gradients. The test temperature was reached in less than 30 minutes, and the clock was set to zero. Very little, if any, peroxide was formed in the time required to heat the fuel to the test temperature.

In preliminary experiments, the oxidized fuel samples were analyzed for peroxides, gums, water, and acid number as was done with the bottle storage samples. These analyses were performed to provide information germane to the oxidation mechanism. However, in the majority of experiments, only peroxide content was measured, and an aliquot sampling procedure was adopted so that several samples could be obtained from a single-batch experiment. The first aliquot of sample was withdrawn through a sampling tube, located about 15 mm above the bottom of the reactor at "time zero", i.e., when the test temperature was reached. Sampling was then continued at convenient time intervals to measure the buildup of peroxide concentration.

IV. RESULTS AND DISCUSSION

A. Global Kinetics of Autoxidation

It is known that autoxidation of hydrocarbons is based on a free-radical mechanism (16-18) and that the intermediate peroxides form in fuels by an oxidation process that is slow at room temperature, but relatively fast at temperatures ranging from 80° to 120°C.(4-11,16-19) Since the objective was to provide a basis for a practical test method, not exceeding about 48 hours,

the foremost goal was to determine if the mechanism of peroxide formation at elevated temperatures was the same as that at ambient temperature. If the mechanism is unchanged over a limited temperature range, e.g., 0° to 150°C, it may be possible to predict ambient temperature behavior from a global Arrhenius rate expression determined from rate measurements at two or more elevated temperatures.

While several relatively complex reaction steps are conceivable in the overall mechanism of autoxidation of hydrocarbon fuels, the formation of hydroperoxides, peroxides, water, and gum; and the role of the antioxidant, *AH*, in the formation of alkyl hydroperoxides, *ROOH*, may be described succinctly by the mechanism shown in TABLE 3, where *NI* is a natural oxidation inhibitor and *RO•*, *OH•*, *R•*, $RO_2\bullet$, and *A•* are free radicals. TABLE 3 is also reproduced here to ease reading.

TABLE 3. Global Mechanism of Autoxidation

Initiation	ROOH	= RO• + OH•	(k_i)	(1)
Radical exchange	RO• + RH	= ROH + R•		(2)
	OH• + RH	= HOH + R•		(3)
Chain propagation	R• + O_2	= $RO_2\bullet$	(k_{1p})	(4)
	$RO_2\bullet$ + RH	= ROOH + R•	(k_{2p})	(5)
Chain breaking	$RO_2\bullet$ + AH	= ROOH + A•	(k_{cb})	(6)
	$RO_2\bullet$ + A•	= Products		(7)
	$RO_2\bullet$ + NI	= Products		(8)
Radical termination	$RO_2\bullet$ + $RO_2\bullet$	= Products	(k_t)	(9)
	R• + R•	= Products	(k_{t1})	(10)

In this mechanism, the alkyl hydroperoxide, *ROOH*, itself, is the radical initiator.(1-6) For a truly pristine fuel, autoxidation would be nearly nonexistent if it were not for a trace of radical initiator such as *ROOH*.

The radical exchange reactions rapidly convert the radicals $HO\bullet$ and $RO\bullet$, formed in the initiation step, to alkyl radicals, $R\bullet$. Alkyl radicals, $R\bullet$, react very rapidly with oxygen to form alkylperoxy radicals, $RO_2\bullet$. Reaction (1p) takes place on almost every molecular collision because it is basically a radical recombination reaction with little or no activation energy. Also, since the concentration of $R\bullet$ is very low compared to the alkylperoxy radical, $RO_2\bullet$, it has even less of an opportunity to react with the antioxidant *AH*. $RO_2\bullet$ tends to build up in the system, and comprises the main radical pool, because it has few reaction partners other than *RH* and *AH*. Recall that Reactions (2p) and (cb) are much slower than Reaction (1p). Because the A-H bond energy in a hindered phenol is significantly less than that of R-H, the activation energy of Reaction (cb) is less than that of (2p). Consequently, $RO_2\bullet$ is more rapidly consumed by *AH*, which explains why the antioxidant depletes the radical pool and slows down the oxidation process. The natural inhibitor, *NI*, is also believed to deplete the radical pool, but it may inhibit the oxidation reaction by a different reaction mechanism.

In the absence of oxidation inhibitors, the radicals are terminated principally by the recombination of $RO_2\bullet$ radicals. Therefore, by neglecting the chain-breaking reactions and making the steady-state approximation for the free-radial concentrations, $[HO\bullet]$, $[RO\bullet]$, $[R\bullet]$, and $[RO_2\bullet]$, the following expression may be derived relating the peroxide concentration, $[ROOH]$, and the oxidation time, τ.

$$\sqrt{[ROOH]} = k_{2p}\sqrt{\frac{k_i}{2k_t}}\,[RH]\tau \qquad \text{(Eq. 1)}$$

or simply:

$$\sqrt{[ROOH]} = k[RH]\tau \approx k'\tau \qquad \text{(Eq. 2)}$$

According to Equation 1, the rate of formation of peroxides is independent of the oxygen concentration and depends only on the hydrocarbon concentration, i.e., the total fuel, which remains essentially constant during the autoxidation process.

It is important to note (16) that the autoxidation rate could become dependent on oxygen concentration, if the partial pressure of oxygen is too low (e.g., ≈ 10 kPa). In the present study, as oxygen concentration dependence at these oxygen levels were not observed, the oxygen pressure of 240 kPa was considered sufficiently high to assume oxygen independent reaction. If the autoxidation is oxygen concentration limited, then Reaction ($1p$) may become a rate-controlling step in the mechanism, and reaction (k_t) would then be replaced by Reaction (k_{t1}).

$$R\bullet + R\bullet \rightarrow R_2 \tag{10}$$

For the oxygen-starved reaction, it can be shown that the peroxide concentration may be expressed as

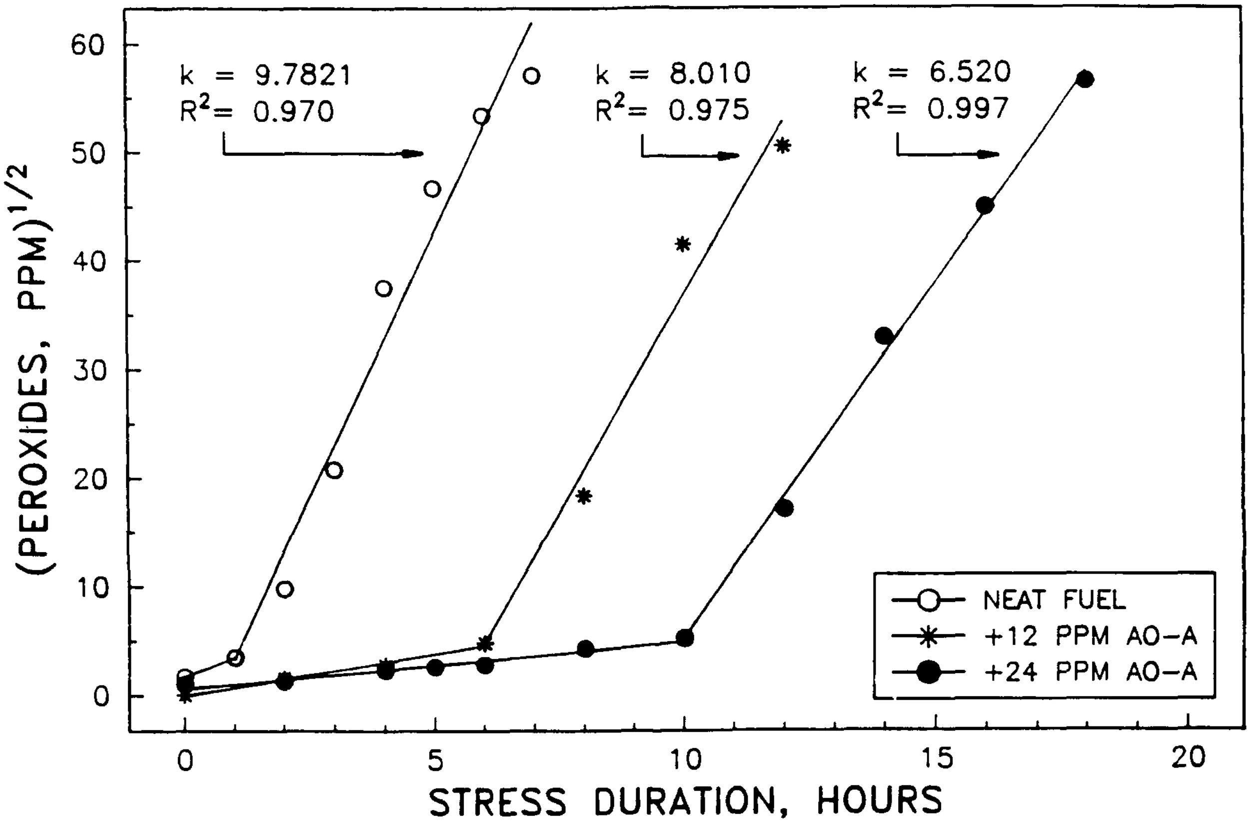
$$\sqrt{[ROOH]} = k_{1p}\sqrt{\frac{k_i}{2k_t}}\,[O_2]\,\tau \qquad \text{(Eq. 3)}$$

where $[O_2]$ is the concentration of oxygen dissolved in the fuel.

Global rate constants for the formation of peroxides during the induction period and post-induction time were determined as the slopes of the curves produced by plotting $[ROOH]^{1/2}$ versus time. Each of the $[ROOH]^{1/2}$ versus time curves was derived from several measurements of peroxide concentrations made throughout the induction period and post-induction time. In that sense, the coefficients of determination, R^2, show that the data correlate very well with the relationship expressed by Equation 1. Induction periods, τ_{ip}, were determined as the time at which the curves for the induction reaction and post-induction reaction cross. Linear regression analyses of these curves are given as discussed later in this report.

B. Oxidation Inhibitors

The following illustration shows typical correlations of the peroxide buildup versus time, as a function of antioxidant concentration, measured at 120°C, based on Equation 1, for the autoxidation of a jet fuel. (Data obtained at 100°C are similar to those shown on the illustration).



Effect of antioxidant concentration on the autoxidation of Fuel 16581 at 120°C

Note that the autoxidation of jet fuels usually proceeds very slowly at first and then at some later time breaks into a relatively fast oxidation reaction. The terms "induction period" and "post-induction reaction" are used to describe the respective slow and fast oxidation processes. "Breakpoint" is often used to denote the end of the induction period or the beginning of the post-induction reaction. An induction period is observed in the autoxidation of the neat fuel. When an antioxidant is used, the induction period increases roughly in proportion to the amount and effectiveness of antioxidant added to the fuel.

Induction periods are observed in the oxidations of most jet fuels. However, sometimes the autoxidations of jet fuels, and more often pure hydrocarbons, exhibit little or no induction period. While the concept of an induction period is not completely understood, it is generally believed that it is caused by naturally occurring oxidation inhibitors in the fuel. This conclusion is based on the observation that, when antioxidants are added to a jet fuel, the induction period is extended. It appears that the antioxidant is depleted at the end of the induction period because there is no effect on the rate of the post-induction reaction. As shown in the illustration and mentioned above, the length of the induction period is roughly proportional to the amount and efficiency of the antioxidant added to the fuel, at either stress temperature. This belief is explained in the following analysis.

For fuels containing antioxidants, the rate of radical termination is dominated by the chain-breaking Reaction 6 (shown in TABLE 3), so

$$k_{cb}[RO_2\bullet][AH] >> k_t[RO_2\bullet]^2 \qquad \text{(Eq. 4)}$$

If the natural inhibitors in the fuel have been consumed, i.e., $[NI] = 0$, and the steady-state approximation is used to derive concentrations of the radicals, $RO\bullet$, $HO\bullet$, $R\bullet$, and $RO_2\bullet$, it may be shown that

$$k_{cb}[RO_2\bullet][AH] = 2k_i[ROOH] \qquad \text{(Eq. 5)}$$

It is important to note that Equation 5 is derived assuming that Reaction 9 is insignificant, i.e., the term $k_t[RO_2\bullet]$ is not included in the steady-state equations.

The illustration above shows the effect of antioxidant concentration on the formation of peroxides in a jet fuel. There is a slight increase in peroxide formation during the induction period. The discrete rise in the formation of peroxides marks the breakpoint or the beginning of the post-induction reaction.

Assuming that AH is consumed only in Reaction 6, it follows that

$$\frac{d[AH]}{dt} = -k_{cb}[RO_2\bullet][AH] \tag{Eq. 6}$$

so by substituting $2k_i[ROOH]$ in Equation 6 for $k_{cb}[RO_2][AH]$ in Equation 4 and integrating $d[AH]$ from $[AH]_0$ to $[AH]$ and dt from $\tau = 0$ to τ_{ip}, the induction period, τ_{ip}, may be expressed as

$$\tau_{ip} = \frac{[AH]_o}{2k_i[ROOH]_{\tau_{ip}}} \tag{Eq. 7}$$

where $[AH]_0$ is the initial concentration of antioxidant and $[ROOH]_{\tau_{ip}}$ is the concentration of peroxide in the fuel at the end of the induction period. Note that $[AH] = 0$ at the end of the induction period. Equation 7 shows that τ_{ip} is proportional to the initial concentration of antioxidant, which agrees reasonably well with the results shown in the illustration on p. 8, and the work of Kendall and Mills.(20)

Basically, Equation 7 shows the effect of antioxidant concentration on induction period for any one antioxidant. However, it does not explain variations in the induction period resulting from differences in antioxidant efficacy. These effects appear to be caused by reactions such as

$$A\bullet + O_2 = AO_2\bullet$$

where the $AO_2\bullet$ radical would then react via

$$AO_2\bullet + RH = AO_2H + R\bullet$$

to continue the chain propagation reaction. These reactions are not included in the steady-state equations used to derive Equation 7. As the antioxidant radical, $A\bullet$, builds up in the fuel, it is expected to have a greater influence on the steady-state concentration of $RO_2\bullet$ radicals. This is why the efficiency of an antioxidant may well depend more on the reactivity of the radical, $A\bullet$, than on the rate of Reaction 6. This reactivity dependence would explain why some antioxidants are more effective than others.

C. Bottle Storage Experiments

Two bottle storage experiments were performed at 43°C, as reported in detail in References 1, 5, and 6. The first, involving fuels 0464, 11310, 11310A, and 11381, were carried out for a total of 24 weeks. The second set of experiments, using fuels 15708 and 16581, lasted for 50 weeks. This work was reported in detail in Reference 9.

Peroxide formation during the 50 weeks of bottle storage at 43°C are shown in TABLE 4, and Fig. 1. Fuel 15708 exhibits an induction period of about 10 weeks, while fuel 16581 does not show increased oxidation rate until about 34 weeks of storage. Equations on the figures give the linear regression equations corresponding to the appropriate induction and post-induction periods.

Changes in vapor phase oxygen concentration during the 50 weeks of bottle storage of the two fuels are shown in Figs. 2 and 3, for fuels 15708 and 16581, respectively. Corresponding data for dissolved oxygen concentrations are illustrated in Figs. 4 and 5. These figures show the results of oxygen depletion and reaeration during the course of the experiments. Note that fuel 15708 begins to use substantial amounts of oxygen after a shorter reaction time than does fuel 16581, i.e., fuel 15708 is more reactive with oxygen than fuel 16581, and, as expected, oxygen uptake runs parallel with increase of peroxide content in the fuels. Also note that, after reaeration, the oxygen concentration in the gas phase returned to 21 vol%, while dissolved oxygen concentration increased to approximately 70 ppm.

It is important to note that, while the gas phase oxygen concentration dropped to about 5 vol% at 4-week intervals, during the same time interval the dissolved oxygen concentration decreased to almost zero. This fact suggests that the vapor phase oxygen supplies the dissolved oxygen content of the liquid phase, which, in turn, is responsible for oxidation of the fuel components. Lack of proper reaeration of these fuel samples would have resulted in diminished peroxidation due to oxygen starvation.

During the 50-week bottle storage experiments, the fuel samples' steam jet gum and water contents were also measured. The rates of both the gum and water formation may be described

by linear induction and post-induction periods that, to some extent, follow the rate of peroxide formation. The first slow, linear segment of gum formation lasted for about 34 weeks for both of these fuels. After the first 34 weeks of oxidation, the rate of gum formation increased. The rate of rapid water formation began after about 15 and 38 weeks of storage for fuels 15708 and 16581, respectively. Total acid numbers of the oxidizing fuels were only followed for the first 34 weeks of storage. During this period, the total acid numbers increased from essentially zero to only the negligible levels of 0.06 and 0.02 mg KOH per gram of fuels 15708 and 16581, respectively.

D. Stirred Reactor Experiments

Results of autoxidation experiments performed on the first six base fuels in the stirred reactors have been published in detail in References 4 through 10. Detailed results of the studies involving the evaluation of the autoxidation of fuels 15708, 16581, 18496, 18497, and the studies involving 13 phenolic antioxidants in fuels 18496 and 18497 were only reported in monthly progress reports. Therefore, a more detailed account of this previously unpublished work will be included in this report.

Results of studies reported in References 8 and 9 are summarized in the following paragraphs.

The rates of peroxide formation in six model kerosenes (fuels 0464, 11310, 11310A, 11381, AV-284, and AV-285) were measured in the temperature range 43° to 120°C with oxygen partial pressures ranging from 20 to 1140 kPa. To explain the rate of peroxide buildup in the fuels, a kinetic model of the autoxidation process was developed on the premise that peroxide decomposition is the principal free-radical initiation step. In accordance with this model, it was found that the square root of the peroxide concentration was proportional to the stress duration. Under the applied rigorous experimental conditions, the global rate constants determined from the peroxide concentration-time histories were independent of the partial pressure of oxygen but strongly dependent on the stress temperature.

Arrhenius correlations of the global rate constants showed that the mechanism of peroxide formation remained unchanged in the temperature range 43° to 120°C. The activation energies of the fuels ranged from 19 to 22 kcal/mol except that for fuel 11310A, which was 29 kcal/mol. Because there was a significant variation in the activation energies of peroxide formation, it was concluded that peroxide potential can not be predicted from rate measurements that are made only at a single elevated temperature. Results of this work encouraged the development of a timely test method to predict rates of peroxide formation at ambient conditions from measurements made at two or more elevated temperatures.

A large number of replicate data points were collected during the autoxidation of fuels 15708 and 16581 to determine statistical scatter of the data obtained within each reactor. Data generated in each reactor were evaluated individually and were also combined to evaluate reactor independent scatter of all data. Additionally, the arithmetic average, the standard deviation, and, where relevant, the coefficient of variation (relative standard deviation) of all data were also evaluated.

Oxidation of fuel 15708 at 80°, 100°, and 120°C are tabulated in TABLES 5 through 7, respectively, while the corresponding data referring to fuel 16581 are given in TABLES 8 through 10. Linear regression analyses of the peroxidation data on fuels 15708 and 16581 are summarized in TABLE 11. Temperature dependence of the rates, i.e., the Arrhenius plot of oxidation of fuels 15708 and 167581, are tabulated in TABLE 12. Graphical presentation of data given in TABLES 5 through 11 are shown in Figs. 6 through 14, respectively.

Experimental data on fuels 15708 and 16581 fully supported the conclusions reached after using the first six fuels, in that

- At any applied reaction temperature, the square root of the formed peroxide concentration was proportional to the oxidative stress duration;

- The measured peroxidation rates were independent of oxygen concentration where the oxygen partial pressure was above 10 kPa (note that in bottle storage experiments, the oxygen concentration dropped several times to below 10 vol%);

- Arrhenius correlation of peroxidation global rate constants versus temperature gave no evidence for a change in mechanism in the 43° to 120°C temperature range;

- Since the activation energy of peroxidation was not identical for all turbine fuels, rates of peroxide formation at ambient conditions may be predicted only if measurements are made at two or more elevated temperatures;

- Coefficient of determination, R^2, of the average of all data obtained in the temperature range of 43° to 120°C for the combination of these two fuels during their induction periods is 0.911, with the corresponding value for the initial linear segment of the post-induction period being 0.977;

- Substantial data base strongly supports the viability of this timely method to determine the peroxidation potential of turbine fuels.

E. Evaluation of Phenolic Antioxidants

1. Introduction

A cooperative study was initiated by the U.S. Naval Air Propulsion Center (NAPC) to assess the effectiveness of 13 commercially available phenolic antioxidants in two additive-free turbine fuels.

Within this study, participation in the cooperative work on the evaluation of antioxidants served two objectives. The first objective was to obtain more data to strengthen the validity of conclusions gained during the earlier parts of the study. The second objective was to demonstrate

that this newly developed methodology, using rigorously controlled experimental conditions, is also eminently suitable to produce timely evaluation of the effectiveness of antioxidants in the retardation of autoxidation of turbine fuels.

Antioxidants were evaluated in terms of time duration of induction period, and the rates of peroxide formation during induction period and the initial linear segment of the post-induction period.

The test matrix consisted of oxidation experiments run in replicate in both Reactors A and B. The 13 antioxidants were examined in both fuels 18496 and 18497 at temperatures of 100° and 120°C. All experiments were run with an antioxidant concentration of 17 mg/L in the fuel. The base fuels were run in replicate in both reactors at different times during the course of the project to uncover possible changes that may have taken place in the fuels since procurement of the fuels.

2. Base Fuels

Two additive-free turbine fuels were procured from two major refiners and were assigned code numbers 18496 and 18497. The refiner of fuel 18496 claimed that this was a hydrocracked product, while the refiner of fuel 18497 stated that its fuel comprised 76 percent of hydrocracked product and 24 percent of hydrotreated light gas oil.

Upon receipt, each fuel was purged with argon, sealed in epoxy-lined steel containers, and stored at ambient temperatures to alleviate uncontrolled fuel degradation.

Since both fuels were to be used to study the effectiveness of antioxidants, compositional differences between the two fuels were expected to influence additive response. The rational of this argument is that the reactivity of hydrocarbons in free-radical reactions, including autoxidations, follows the stability of the intermediate radicals because the more stable radicals are easier to form. The reactivity of compounds containing benzylic hydrogens, C_6H_5-CH, and

allylic hydrogens, C=C-CH, are highest, followed by, in decreasing order, the reactivity of hydrogen on tertiary (C_3CH), secondary (C_2CH_2), and finally on primary carbon atoms (CH_3). Reactivity across an olefinic carbon-carbon double bond is highest if ionization of that bond takes place, e.g., in case of halogen addition. Therefore, it was deemed necessary to subject both fuels to relatively detailed compositional analysis by gas chromatography using a mass selective detector (GC/MS).

Analysis has shown that the aromatic hydrocarbon contents of the two fuels are widely different, as determined by the ASTM D 1319 (FIA) method and by an ultraviolet (UV) spectroscopic method (21,22), developed at Southwest Research Institute. The UV method provides data on the aromatic ring-carbon content of middle distillate fuels. These results may be summarized as follows:

Analysis of Aromatic Hydrocarbons	18496	18497
Aromatics by FIA, vol%	20.6	8.5
Monocyclic aromatic ring C, wt%	20.60	3.25
Dicyclic aromatic ring C, wt%	5.51	0.92
Tricyclic aromatic ring C, wt%	0.22	0.04
Total aromatic ring C, wt%	26.33	4.21

Analysis by GC/MS was performed on both fuels. To ease interpretation of GC/MS results, the complexity of both fuels was reduced by preseparating them into two fractions, consisting of (a) "nonpolar" compounds, mainly saturated hydrocarbons and olefins, and (b) polar compounds, principally aromatic hydrocarbons. The preseparations were performed using high-performance liquid chromatography (HPLC) over activated silica gel. Elution of the "nonpolar" fraction was accomplished using n-hexane, while the polar compounds were "backwashed" with methylene chloride. The solvents were evaporated at room temperature under vacuum. The separated fractions were then individually analyzed by high-resolution capillary GC/MS.

Gas chromatographic conditions for the analysis of the preseparated turbine fuel fractions are shown in TABLE 13. The capillary column of the GC was directly interfaced into the mass

spectrometer's source through a heated interface tube held at 280°C. The operating conditions for the mass spectrometer are summarized in TABLE 14.

The mass spectrometer-generated total ion chromatograms (TIC) revealed the presence of several hundred peaks for each fraction. Integration threshold was adjusted to detect only those peaks that the total integration showed to be present at TIC area percents of approximately 0.2 percent or greater. Due to lack of reference compounds, quantitation of the samples represents area percents rather than actual concentrations of the compounds.

The mass spectrum of each peak was generated and subjected to computerized library search using the Wiley Library data base, containing about 80,000 spectra, and the NBS Library, containing over 38,000 compounds. The generated spectra and library search results were then studied to confirm or correct identifications.

The identified compounds and the corresponding area percents are tabulated in TABLES 15 and 16, enumerating the identified compound classes within the nonpolar and polar fractions, respectively. The relatively low 70 to 89 percent identification of the fractions is due to the lack of appropriate response factors and the multitude of unidentified trace components. It must also be stressed that there is a possibility that trace quantities of unidentified substances may share the responsibility for the dissimilar reactivities of these fuels.

Composition of the identified portion of the polar fractions of the two base fuels did not seem to be remarkable. Analysis of the nonpolar fractions, however, revealed some interesting differences between the two fuels. Normal- and iso-paraffin concentrations were approximately twice as high in fuel 18496 than in fuel 18497. Cycloparaffin and olefin concentrations were substantially higher in fuel 18497 than in fuel 18496.

Baseline oxidation experiments on additive-free fuels No. 18496 and 18497 have been performed at 80°, 100°, and 120°C in the two nominally identical Type 316 stainless steel reactors under "ultrahigh purity" (99.99%) oxygen, as described previously. Oxygen pressure in the reactors was maintained at 240 kPa (20 psig), as set at room temperature. Aliquots of the fuel were taken

hourly during the 120°C runs, and every 5 hours during the experiments conducted at 80° and 100°C.

Baseline oxidation experiments on additive-free base fuels 18496 and 18497 have been performed twice in Reactors A and B at different times in the course of the project, both at 100° and 120°C.

During the second set of baseline runs, performed approximately 1 year after the fuels were delivered, it was noted, that while the induction period of oxidation at 100°C remained approximately 20 hours for fuel 18496, the induction period for fuel 18497 increased from 15 to 20 hours. These same effects were not observed during the repeated 120°C experiments. The reason(s) for the observed change in the induction period of fuel 18497 were not explored. The observed change may be real, or it may relate to uncertainty in the determination of induction periods to within a 5-hour precision at 100°C. In TABLE 78, and in Figs. 76 and 77, accounts are made for this change when the relative effectiveness of the various antioxidants are presented.

The first set of oxidation data on the two base fuels is summarized in TABLES 17 through 22, and are graphically shown in Figs. 15 through 22. Linear regression analysis of the peroxidation data are summarized in TABLE 23. TABLE 23 includes evaluation of data obtained at all three temperatures individually in Reactor-A, in Reactor-B, the combined data to indicate the reactor-independent response of data, and the arithmetic averages of all data. Time duration of each reaction segment is specified. The coefficient of determination, or squared correlation coefficient, R^2, values indicate the closeness of fit of the experimental data to the predicted linear correlation of the time dependence of the square root of the peroxide number. During all induction periods summarized in TABLE 23, the average R^2 was found to be 0.881, with a standard deviation of 0.073. Corresponding R^2 value during all post-induction periods summarized in TABLE 23 is 0.965, with a standard deviation of 0.031. The combined average data obtained at 80°, 100°, and 120°C for fuels 18496 and 18497 are graphically shown in Figs. 18 and 22.

Test results show that even the additive-free (artificially uninhibited) base fuels, 18496 and 18497, have induction periods, as observed for most other turbine fuels. Induction periods in these fuels are attributed to unknown natural antioxidants.

Temperature dependence of the global reaction rates, or Arrhenius correlations of the global autoxidation rate constants, calculated from the average data, are given in TABLE 24. The same data are graphically illustrated in Fig. 23. The obtained high R^2 values are noteworthy. It is seen that the global energy of activation, E_a, is different for the two fuels, both during and after the induction periods. For this reason, as observed earlier, it is not advised to predict peroxidation potential of these, or other unproven turbine fuels at ambient temperatures by extrapolating reaction rates measured only at a single elevated temperature.

Activation energies measured for the 10 turbine fuels during the course of this study are between 19 and 29 kcal/mol/K in the temperature range of 43° to 120°C. In previous studies workers have estimated the rate of peroxide formation at higher temperatures from the old generalized Arrhenius assumption that the rate of a reaction doubles for every 10°C increase in temperature. Calculation of activation energy for a reaction in which the rate doubles for each 10 K temperature rise indicates that the activation energy does not remain constant with temperature. In other words, the plot of *ln k* versus *1/T* of the rate constant obtained with the old Arrhenius assumption gives a curve of varying slope. The activation energies derived from the slopes at temperatures of 25°, 43°, 65°, 80°, 100°, and 120°C are 12.32, 14.05, 16.17, 17.60, 19.47, and 21.27 kcal/mol, respectively. In contrast, the measured activation energies for peroxide formation in the temperature range of 43° to 120°C for the model fuels were found in the range of 22.7 and 28.7 kcal/mol/K, substantially higher than the assumed activation energy range of 12 to 21 kcal/mol/K. Further, the measured activation energies were linear for each fuel within the measured temperature range. For these reasons, when describing autoxidation of turbine fuels, it is unreasonable to use the simplified Arrhenius assumption that "reaction rate doubles for each 10 K temperature rise," as it may lead to erroneous conclusions. Doubling of the global turbine fuel autoxidation reaction rates for each 10 K temperature rise, therefore, should not be assumed.

Results of this work suggest that it is possible to calculate a characteristic time for the formation of a specified critical peroxide concentration from timely measurements carried out on the fuel at elevated temperatures. According to current specifications, a fuel is unacceptable when its peroxide content exceeds 8 ppm. For the simplified case, in which global rate constants were

measured at only two temperatures, the characteristic time (t) required for 8 ppm of peroxide to form in the fuel at ambient temperature, T_a, may be expressed as

$$t = \left(\frac{\sqrt{8}}{k_1}\right)\left(\frac{k_1}{k_2}\right)^b \qquad \text{(Eq. 8)}$$

where k_1 and k_2 are the global rate constants determined at elevated temperatures T_1 and T_2, and the exponent, b, is

$$b = \frac{T_2}{T_a}\left(\frac{T_1 - T_a}{T_1 - T_2}\right) \qquad \text{(Eq. 9)}$$

The global rate constants k_1 and k_2 are determined at high temperatures, e.g., at T_1 = 120°C and T_2 = 100°C, by plotting the square root of the peroxide concentration versus stress duration for each temperature, and then taking the slopes of the lines.

3. Antioxidant Effects at 100°C

Since most of the 13 antioxidants are multicomponent mixtures, they will be referred to by alphabetical designations, as identified in TABLE 25. Each antioxidant was dissolved in both fuels at a concentration of 17 mg/L, and were oxidized in the stirred pressurized reactors under 240 kPa of ultrapure oxygen at 100° and 120°C. Each reaction was run in replicate long enough to establish a reliable slope, i.e., global autoxidation rate constant, not only for the induction period, but also for the first, linear segment of the post-induction period.

To provide a complete data set, all data obtained under the listed experimental conditions are given in the tables and figures presented. To reduce the complexity of presentation, the figures show the data obtained in both reactors and the linear regression line corresponding to the

average data. When the figures require, the induction periods were determined as the calculated intercept of the induction period and post-induction period regression lines.

Results of the 100°C oxidation experiments of fuel 18496 doped with the 13 antioxidants are given in TABLES 26 through 38, and in Figs. 24 through 36. Corresponding data obtained using fuel 18497 are presented in TABLES 39 through 51 and Figs. 37 through 49. Summaries of the measured and calculated data are given in TABLE 78 and shown graphically in Figs. 76 and 77.

The average of all R^2 values derived from the 100°C experiments, as summarized in TABLE 78, are 0.910, with a standard deviation of 0.064, and 0.965, with a standard deviation of 0.034, for the induction periods and for the post-induction periods, respectively. Corresponding values derived from the 120°C experiments are: $R^2 = 0.941$ with standard deviation of 0.025, and $R^2 = 0.989$ with standard deviation of 0.009, for the induction and post-induction periods, respectively.

The presented data indicate that the global rate constant for the formation of peroxides during the induction period was reduced by the antioxidants, while the post-induction rates remained essentially unchanged.

The observed antioxidant susceptibilities of the two fuels were strikingly different, as shown in Figs. 76 and 77. Identical concentrations of antioxidants increased the induction periods of the doped fuel 18497 substantially more than that observed for fuel 18496. Relative efficiencies of antioxidants were found to be highest for antioxidants A, B, C, E, F, and H, while antioxidants I through N performed poorest.

4. <u>Antioxidant Effects at 120°C</u>

Results of the 120°C experiments for the antioxidant-doped fuel 18496 are tabulated in TABLES 52 through 64 and Figs. 50 through 62. Corresponding data for fuel 18497 are given in TABLES 65 through 77 and are shown in Figs. 63 through 75. Overall summary of the measured and calculated data are provided in TABLE 79 and Figs. 78 and 79.

Dissimilar antioxidant susceptibility of the two fuels, noted during the 100°C experiments, were also observed during the studies conducted at 120°C. Again, the observed induction periods for the antioxidant-doped fuel 18497 were substantially longer that those measured in fuel 18496. Relative efficiencies of the antioxidants correspond to those measured at 100°C, except that, at 120°C, antioxidant C did not lengthen the induction period in the fuels to be comparable to the more efficient antioxidants A, B, E, F, and H, as was observed at 100°C. The poorest performing antioxidants I through N parallel their poorer performance exhibited at 100°C.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Using a rather large experimental matrix, 10 additive-free turbine fuels were oxidized under varied conditions to develop a method to predict the peroxidation potential of turbine fuels and to evaluate the effectiveness of antioxidants. The experimental conditions included autoxidations under air at atmospheric pressure and under pure oxygen at several pressures ranging between 240 and 1140 kPa. The reactions were performed at six temperatures between 43° and 120°C. Except for the tests conducted using air at atmospheric pressure, the experiments were carried out using pure oxygen in unvented stirred stainless steel reactors. The oxygen pressure in the vapor phase was regulated, and the temperature was maintained within ±0.5°C. Special provisions were made to maximize control over the experimental conditions, e.g., to exclude contamination of the test fuel by components of other fuels and to exclude the possibility of altering the composition of the test fuel by uncontrolled evaporation, common elements of most other similar procedures.

Within the experimental constraints, the data indicate that

- At any applied reaction temperature, the square root of the formed peroxide concentration is proportional to the oxidative stress duration;

- The average coefficient of determination, R^2, at 100°C for all induction periods, i.e., the neat fuels and the antioxidant-doped fuels, is 0.908. The corresponding coefficient of determination for the post-induction periods is 0.966. At 120°C, the corresponding

average R^2 for all the fuels, during the induction periods, is 0.940 and 0.988 for the corresponding post-induction periods;

- The measured peroxidation rates were independent of oxygen concentration when the oxygen partial pressure was above 10 kPa (note that in bottle storage experiments, the oxygen concentration dropped several times to below 10 vol%, corresponding to about 10 kPa);

- Arrhenius correlation of peroxidation global rate constants versus temperature gave no evidence for a change in mechanism in the 43° to 120°C temperature range;

- Since the activation energy of peroxidation was not identical for all turbine fuels, rates of peroxide formation at ambient conditions may be predicted only if measurements are made at two or more elevated temperatures;

- As most base fuels gave rise to an induction period of oxidation, it is proposed that these fuels contain some unidentified natural antioxidant(s).

In all cases studied, chemical kinetics conclusions reached using antioxidant-free base fuels were also supported by data obtained using antioxidant-doped fuels, as Equation 1 satisfactorily described the overall autoxidation reactions.

Linear regression analysis of data obtained during the experimental runs gave excellent agreement with presented theory, and the derived standard deviation, coefficient of variation (relative standard deviation), and coefficient of determination, R^2, all provided excellent values, apparently limited mainly by the limits of the iodometric titrations for peroxides, as described in ASTM D 3703.

It should be noted that temperature control of the reaction was found to be critical to obtain reproducible, credible data. While no detailed study was conducted to define temperature tolerance limits in these experiments, indications are that temperature should be held constant to

within ± 0.5°C. This finding was not a surprise, but a natural requirement of any measurement in chemical kinetics.

The 13 hindered phenolic antioxidants tested in the two turbine fuels lead to essentially coinciding ranking of the products at 100° and 120°C.

As expected, the more highly hindered phenols proved to be more efficient oxidation inhibitors in the turbine fuels examined.

Evaluation of the more efficient antioxidants required about 120 to 150 hours at 100°C, but only 25 to 40 hours at 120°C.

Antioxidant response of the two base fuels were vastly different. In an attempt to explain the difference in antioxidant susceptibility, both fuels were analyzed by GC/MS.

Based on a limited number of experiments performed on two test fuels, hydrocarbon-type analysis, as presented on page 16 and in TABLES 15 and 16, suggests that the effectiveness of antioxidants is reduced by increased aromatic hydrocarbon content in the base fuel. It is probable that the higher stability of the additive-free fuel 18496 is due to its higher normal-paraffin concentration in comparison to that of fuel 18497. The higher level of antioxidant effectiveness, i.e., inhibition of fuel 18497, as opposed to fuel 18496, may be due to reactions at the more abundant allylic positions in fuel 18497. Further, the higher concentrations of cycloparaffins (which are more reactive than the normal paraffins) of fuel 18497 may also contribute to this behavior.

The substantial data base presented in this report strongly supports the viability of this timely research grade analytical tool to determine the peroxidation potential of turbine fuels and to evaluate the effectiveness of antioxidants in turbine fuels.

It is strongly recommended that this research-type analytical tool be modified to be more easily usable for routine testing and evaluations. This work should be followed by full cooperative

evaluation of the methodology in a round-robin type procedure prior to its adaption as a standard analytical method of choice for (a) estimation of storage stability of turbine fuels, (b) for the evaluation of antioxidants, and (c) for the determination of susceptibility of turbine fuels to antioxidants.

VI. LIST OF REFERENCES

1. Shertzer, R.H., "Aircraft Systems Fleet Support/Organic Peroxides in JP-5 Investigations," Final Report, NAPC-433, Naval Air Propulsion Center, Trenton, NJ, 1978.

2. Hazlett, R.N., Hall, J.M., Nowack, C.J., and Craig, L.M., "Hydroperoxide Formation in Jet Fuels," Proc. of Conference on Long-Term Stability of Liquid Fuels," Tel Aviv, Israel, No. B132, 1983.

3. Love, B.E., Hatchett, K.A., and Peat, A.E., "Fuel Related Problems in Engine Fuel Systems," SAE Technical Paper No. 660714, 1966.

4. Fodor, G.E., Naegeli, D.W., Kohl, K.B., and Cuellar, Jr., J.P., "Development of a Test Method to Determine Potential Peroxide Content in Turbine Fuels," Interim Report BFLRF No. 199 (AD A163590), prepared by Belvoir Fuels and Lubricants Research Facility, Southwest Research Institute, San Antonio, TX, June 1985.

5. Fodor, G.E. and Naegeli, D.W., "Development of a Test Method to Determine Potential Peroxide Content in Turbine Fuels," Conference Proceedings, 2nd International Conference on Long-Term Storage Stabilities of Liquid Fuels, San Antonio, TX, pp. 632-645, July 29-August 1, 1986.

6. Fodor, G.E., Naegeli, D.W., Kohl, K.B., and Cuellar, Jr., J.P., "Development of a Test Method to Determine Potential Peroxide Content in Turbine Fuels - Part II," Interim Report BFLRF No. 243 (AD A189293), prepared by Belvoir Fuels and Lubricants Research Facility, Southwest Research Institute, San Antonio, TX, June 1987.

7. Fodor, G.E., Kohl, K.B., and Naegeli, D.W., "Application of Nondestructive Evaluations to the Prediction of Turbine Fuel Peroxidation Potential," Final Report No. SwRI-7958-840, prepared by Southwest Research Institute, San Antonio, TX, January 1988.

8. Fodor, G.E., Naegeli, D.W., and Kohl, K.B., "Peroxide Formation in Jet Fuels," *Energy & Fuels*, 2, pp. 729-734, 1988.

9. Fodor, G.E. and Turner, L.M., "Development of a Test Method to Determine Potential Peroxide Content in Turbine Fuels," Coordinating Research Council Meeting on Oxidation Stability of Gas Turbine Fuels, Arlington, VA, April 26, 1989.

10. Fodor, G.E. and Naegeli, D.W., "Peroxide Formation in Jet Fuels," Preprints of papers presented at the 200th ACS National Meeting, Symposium on Stability and Oxidation Chemistry of Middle Distillate Fuels, Washington, DC, Volume 35, No. 4, pp. 1267-1276, August 26-31, 1990.

11. Fodor, G.E., Naegeli, D.W., and Turner, L.M., "Inhibition of Peroxide Formation by Hindered Phenols in Jet Fuels," Preprints of papers presented at the 203rd ACS National Meeting, Division of Petroleum Chemistry, Symposium on Structure of Jet Fuels, San Francisco, CA, Volume 37, No. 2, p. 403, April 5-10, 1992.

12. Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method), ASTM D 2274.

13. Standard Test Method for Distillate Fuel Storage Stability at 43°C (110°F), ASTM D 4625.

14. "Determination of the Hydroperoxide Potential of Jet Fuels," CRC Report No. 559, Coordinating Research Council, Inc., 219 Perimeter Center Parkway, Atlanta, GA.

15. Hall, J.M., "Memorandum to Participants in the Third CRC Cooperative Test Program on Hydroperoxide Potential of Jet Fuels," 7 April 1986.

16. Walling, C., "Free Radicals in Solution," Chapter 9, John Wiley and Sons, Inc., New York, NY, 1957.

17. Frost, A.A. and Pearson, R.G., "Kinetics and Mechanism," John Wiley and Sons, Inc, New York, NY, 1961.

18. Hine, J., "Physical Organic Chemistry," McGraw-Hill Book Co., New York, NY, 1956.

19. Watkins, Jr., J.M., Mushrush, G.W., and Hazlett, R.N., Preprint of paper, American Chemical Society, Division of Fuel Chemistry, 32(1), pp. 513-521, 1967.

20. Kendall, D.R. and Mills, J.S., "Thermal Stability of Aviation Kerosines: Techniques to Characterize Their Oxidation Properties," Ind. Eng. Chem. Prod. Res. Dev. 25, p. 360, 1986.

21. Newman, F.M. and Greenberg, M.K., "Determination of Aromaticity of Fuels and Lubricant Basestocks by Ultraviolet Spectroscopy," Presented at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, March 1978.

22. Newman, F.M. and Greenberg, M.K., "Determination of Aromaticity of Fuels and Lubricant Basestocks by Ultraviolet Spectroscopy," Interim Report No. 10 (AD A086654), prepared by U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, TX, February 1980.

ILLUSTRATIONS

PEROX1/JOHN101.PLOT

Figure 1. PEROXIDE FORMATION DURING 43 °C BOTTLE STORAGE

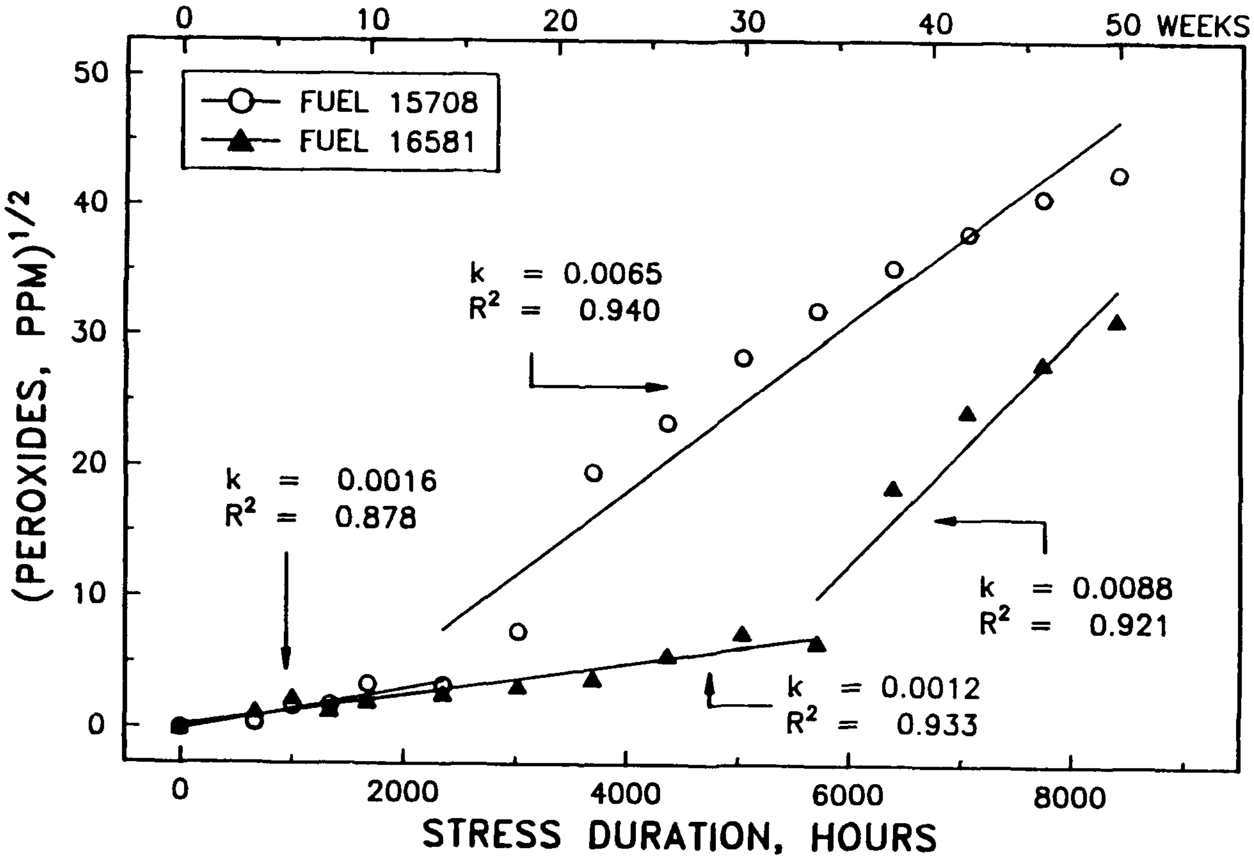
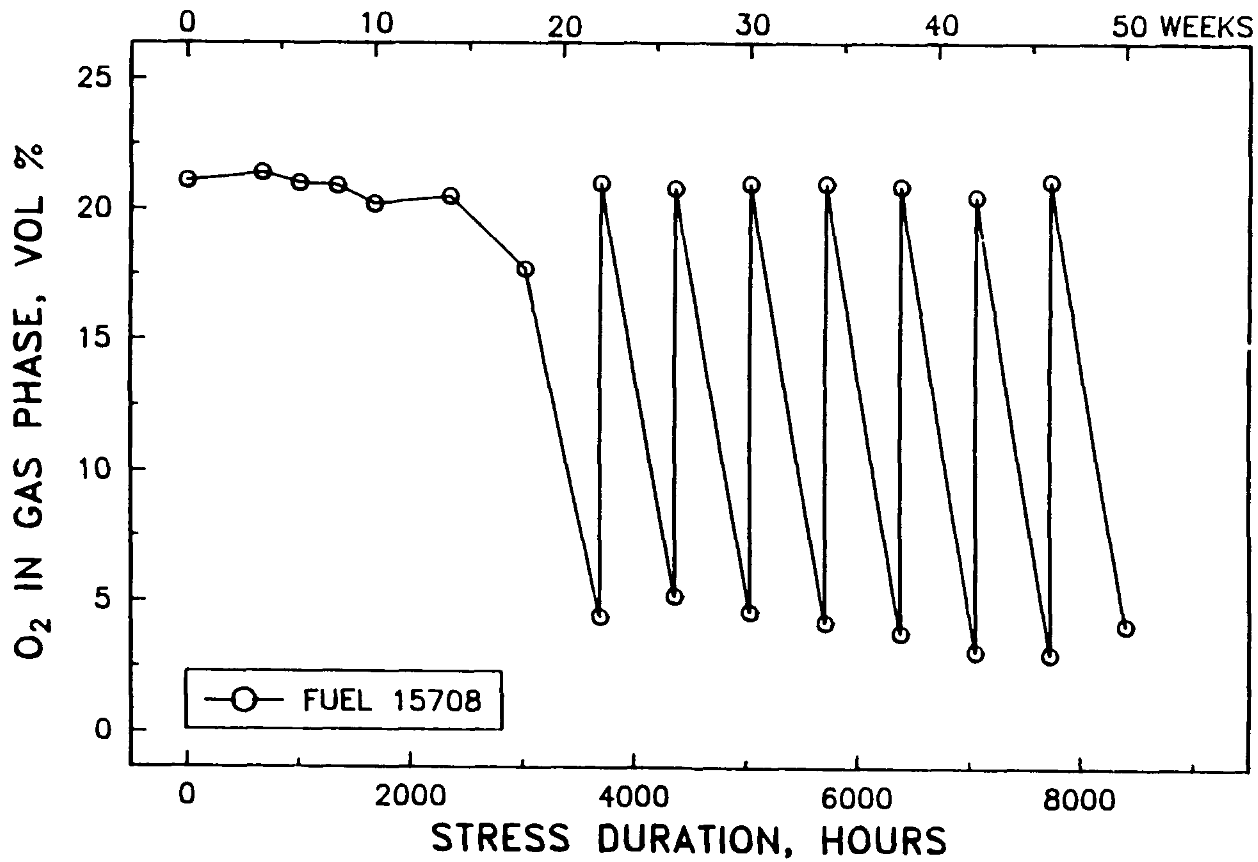


Figure 2. GAS PHASE OXYGEN CONCENTRATION DURING 43 °C BOTTLE STORAGE



PEROX1/JOHN111B.PLOT

Figure 3. GAS PHASE OXYGEN CONCENTRATION DURING 43 °C BOTTLE STORAGE

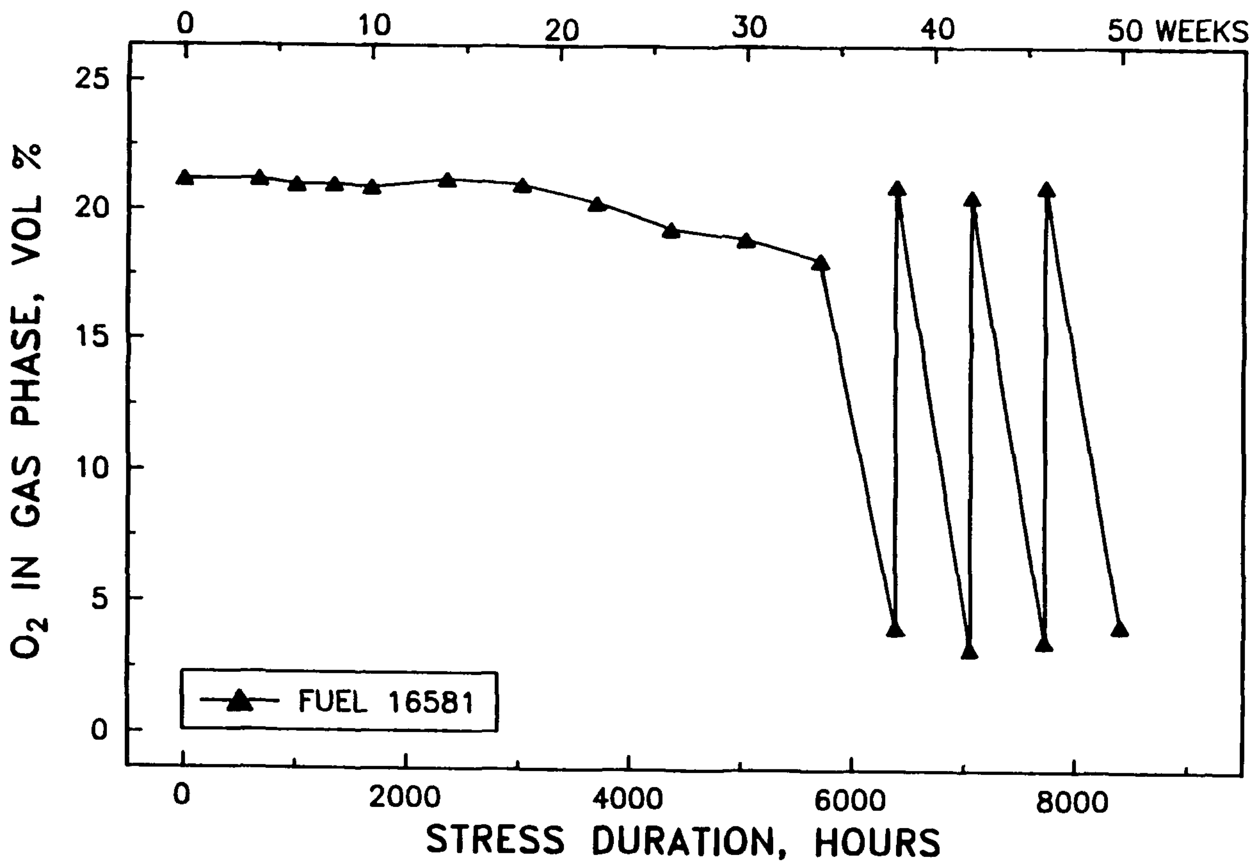
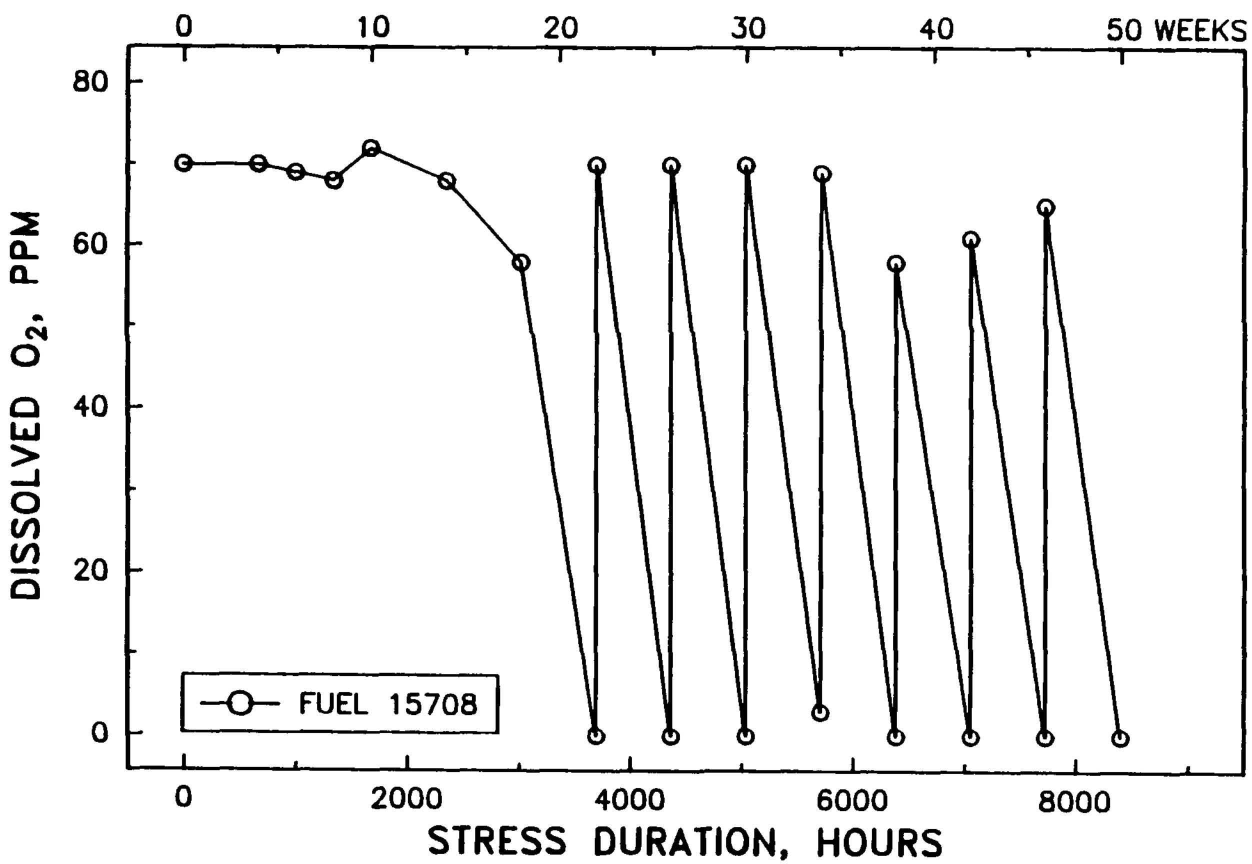


Figure 4. LIQUID PHASE OXYGEN CONCENTRATION DURING 43 °C BOTTLE STORAGE



PEROX1/JOHN121B.PLOT

Figure 5. LIQUID PHASE OXYGEN CONCENTRATION DURING 43 °C BOTTLE STORAGE

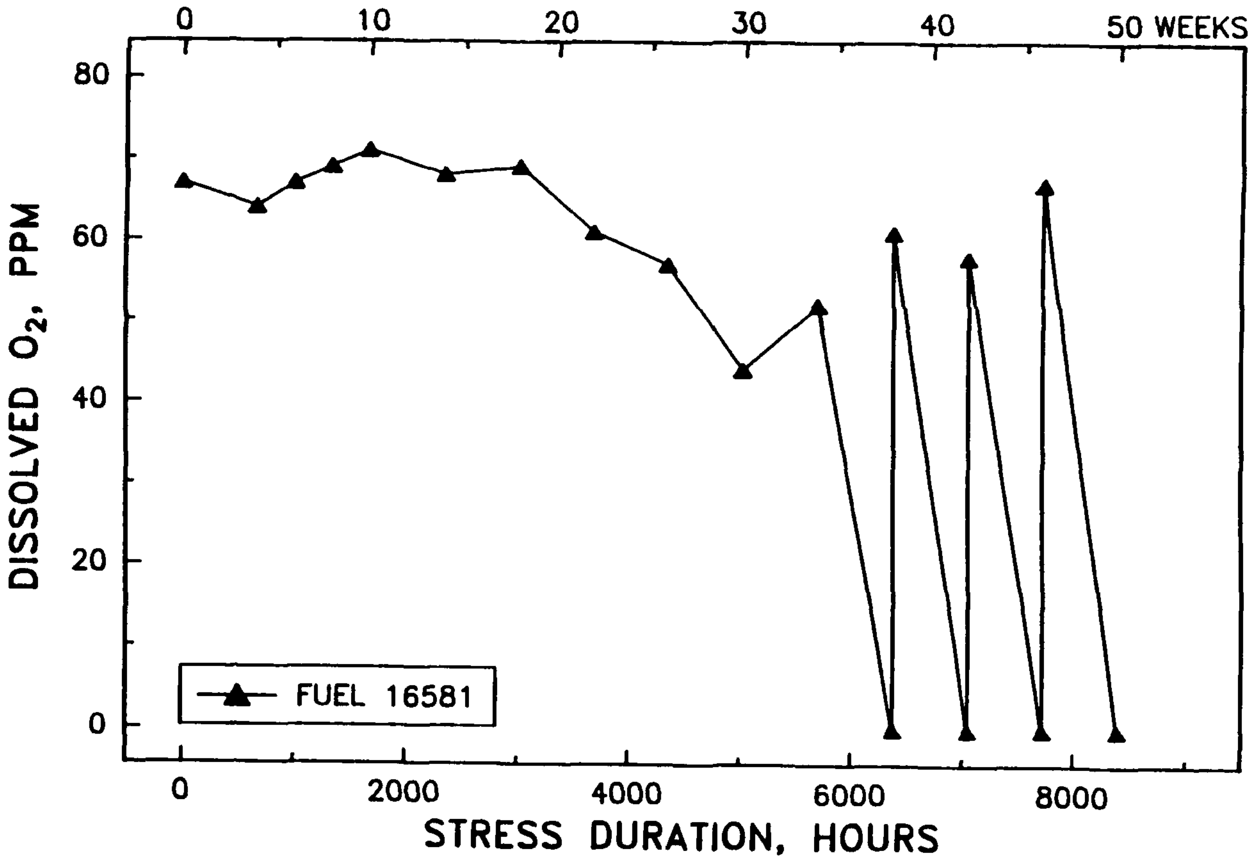


Figure 6. OXIDATION OF FUEL 15708
AT 80°C UNDER 240 kPa OXYGEN

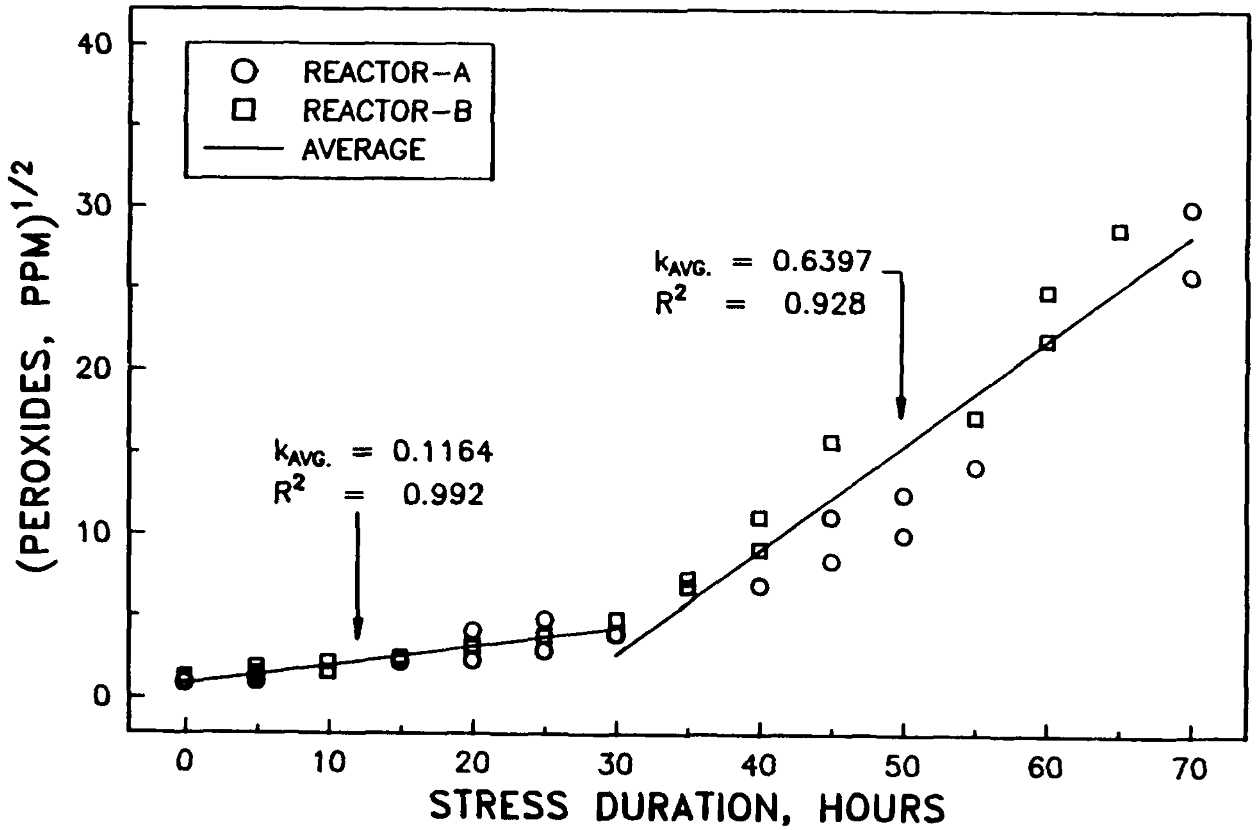


Figure 7. OXIDATION OF FUEL 15708 AT 100°C UNDER 240 kPa OXYGEN

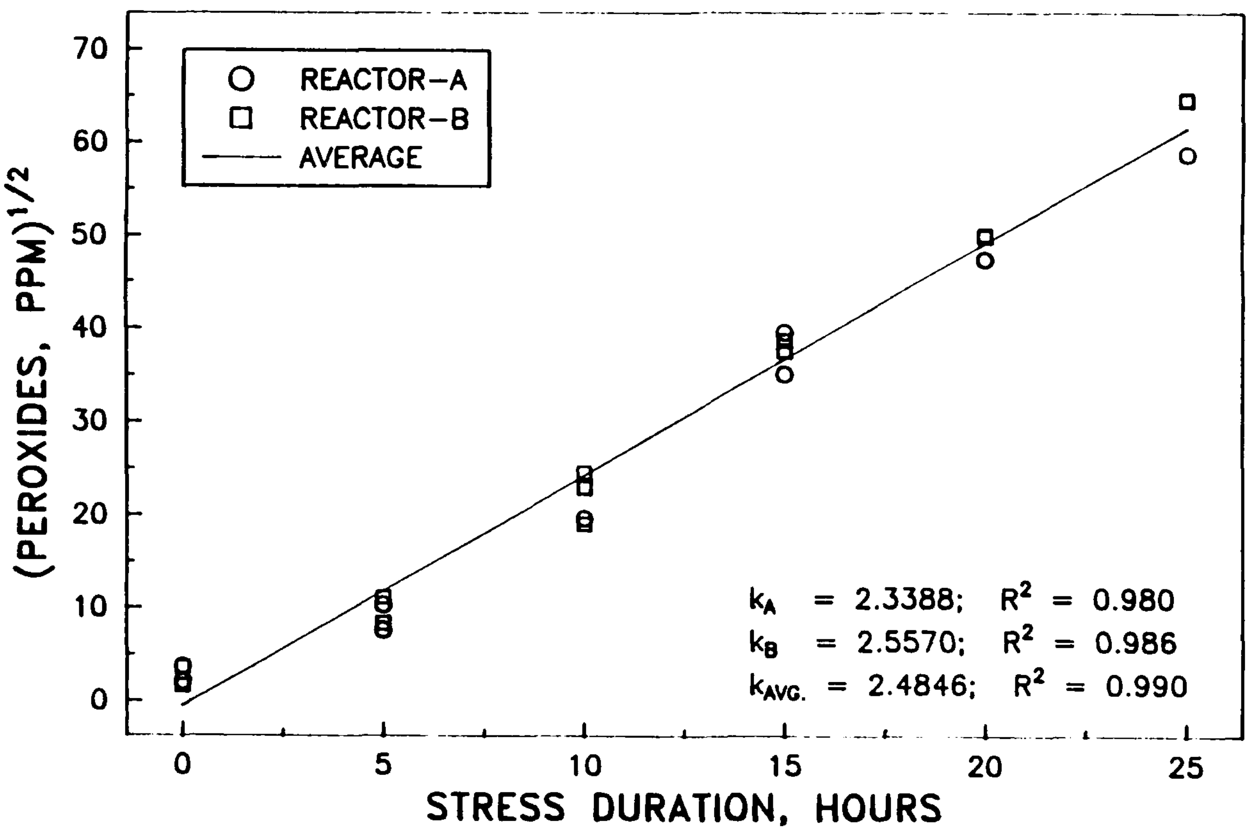


Figure 8. OXIDATION OF FUEL 15708 AT 120 °C UNDER 240 kPa OXYGEN

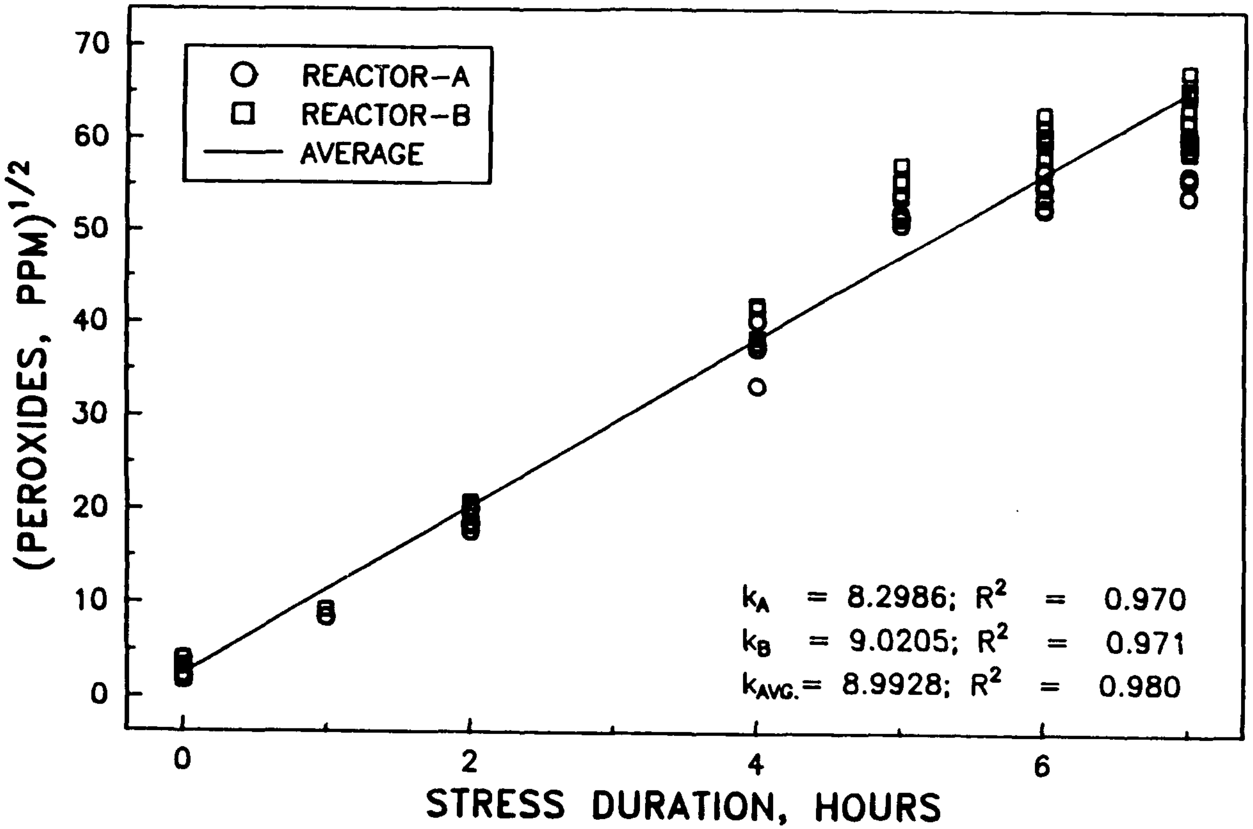


Figure 9. OXIDATION OF FUEL 15708
UNDER 240 kPa OF OXYGEN

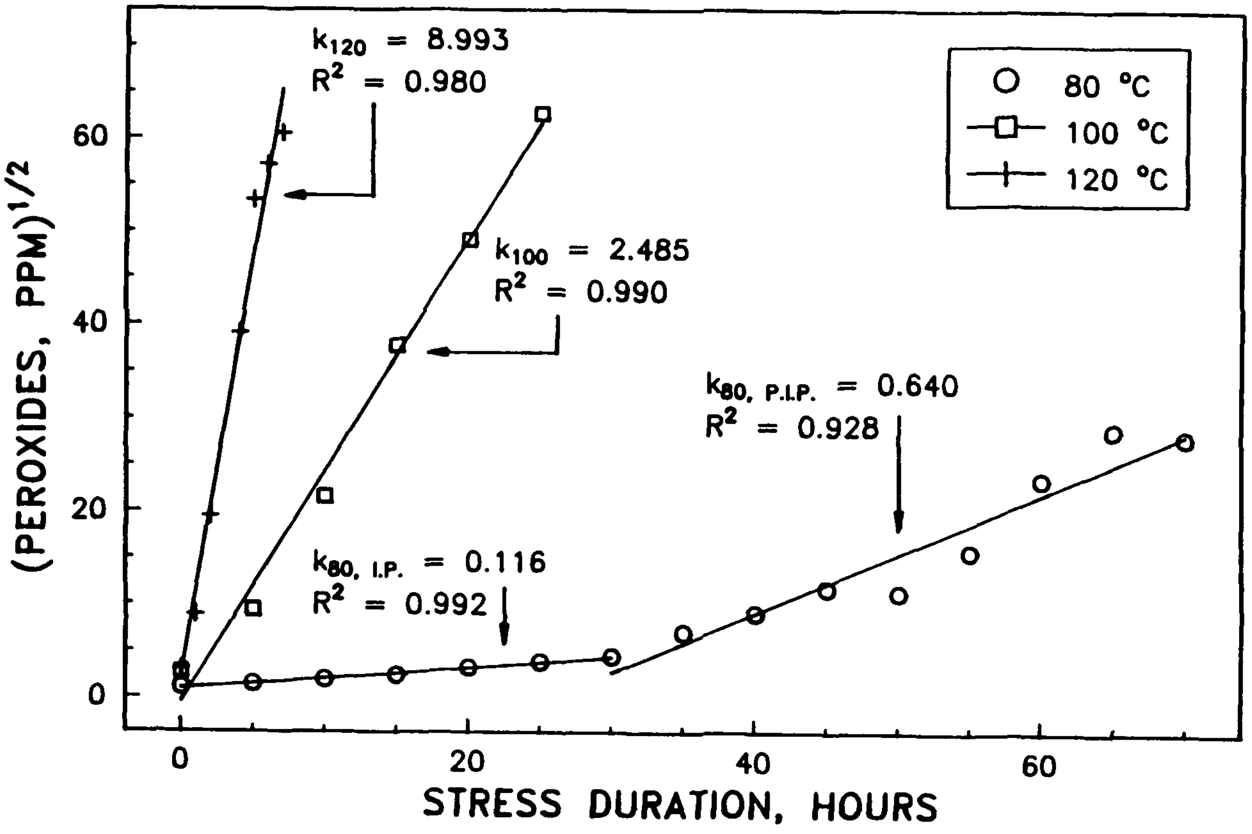
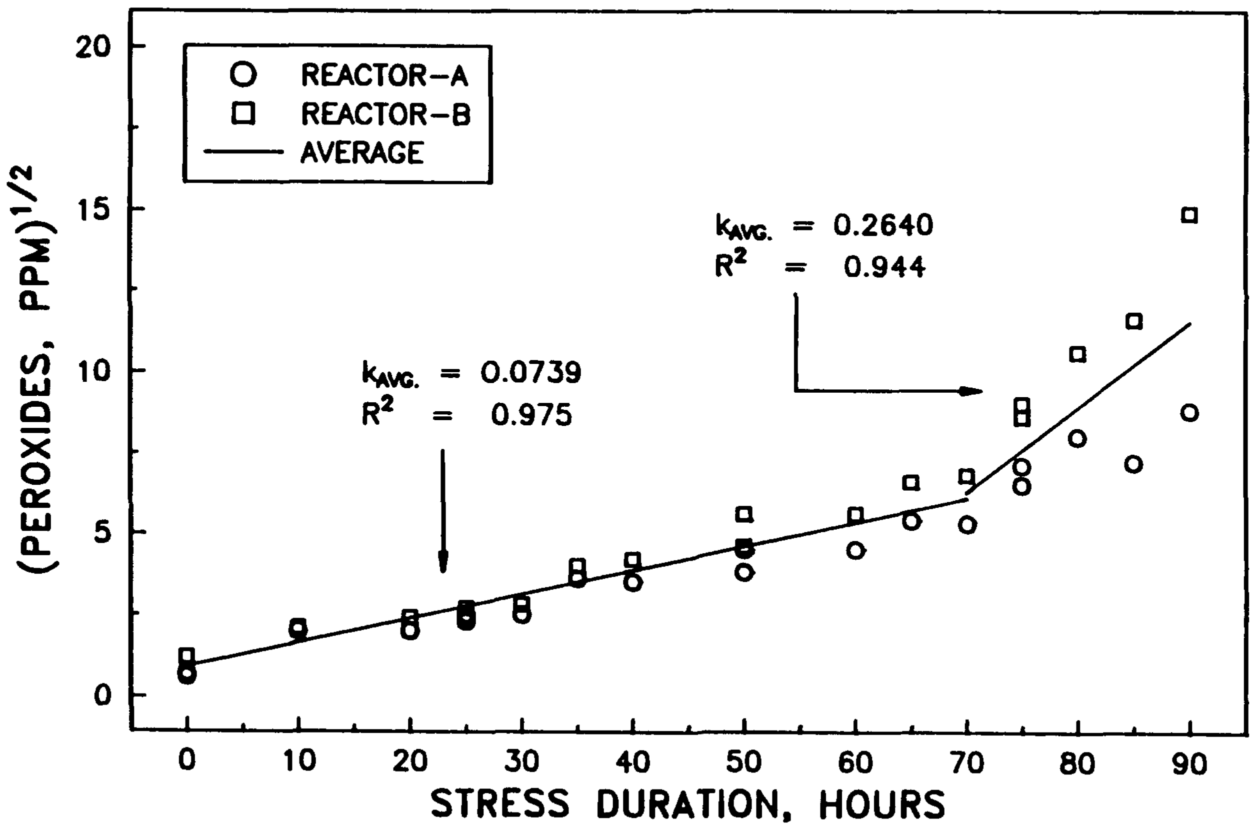


Figure 10. OXIDATION OF FUEL 16581
AT 80 °C UNDER 240 kPa OXYGEN



PEROX1/PER61.PLOT

Figure 11. OXIDATION OF FUEL 16581 AT 100 °C UNDER 240 kPa OXYGEN

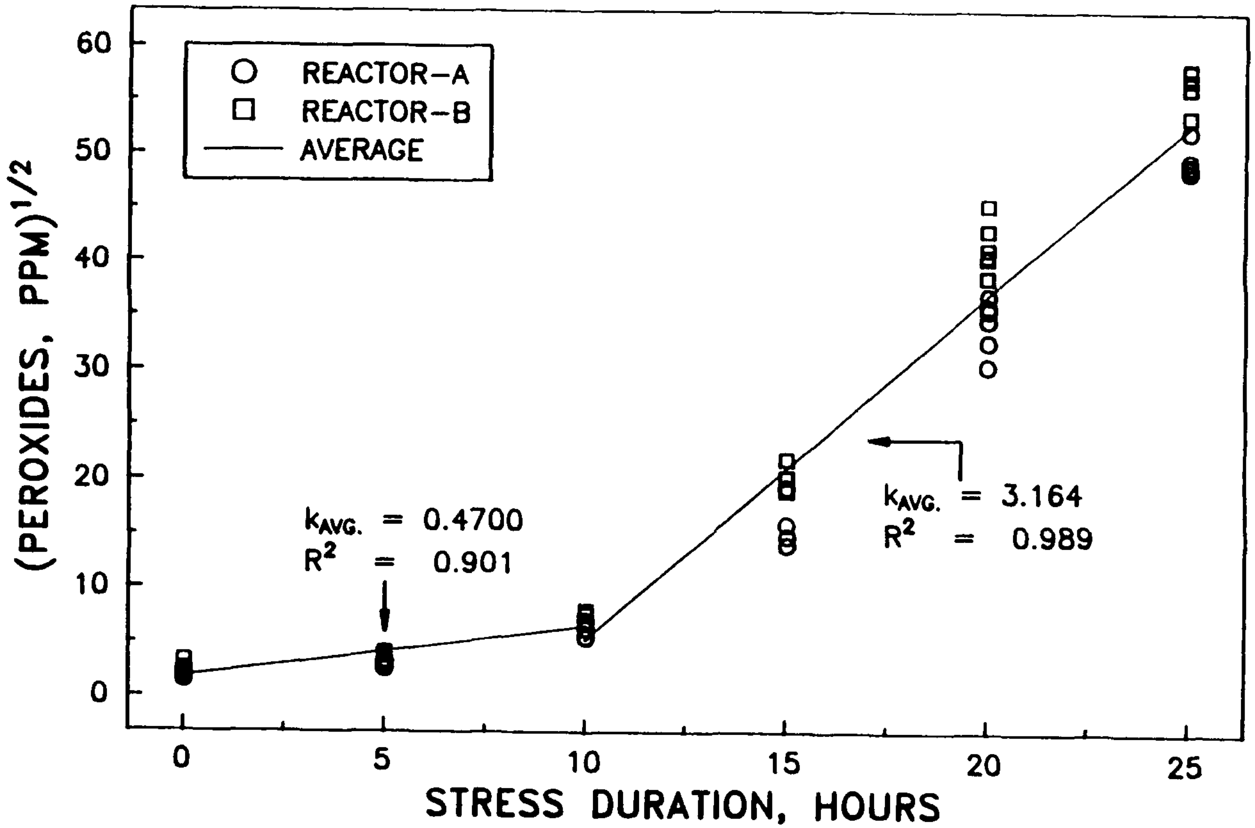


Figure 12. OXIDATION OF FUEL 16581 AT 120°C UNDER 240 kPa OXYGEN

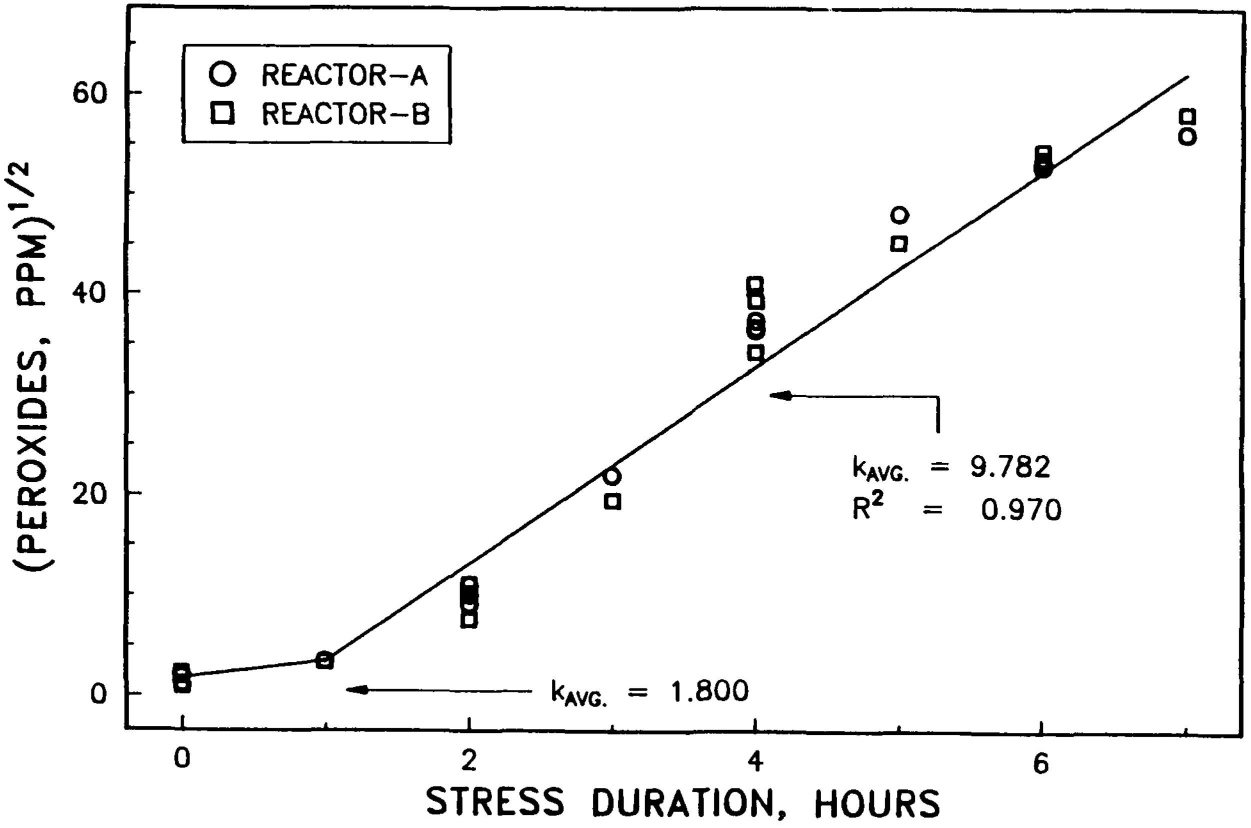


Figure 13. OXIDATION OF FUEL 16581 UNDER 240 kPa OF OXYGEN

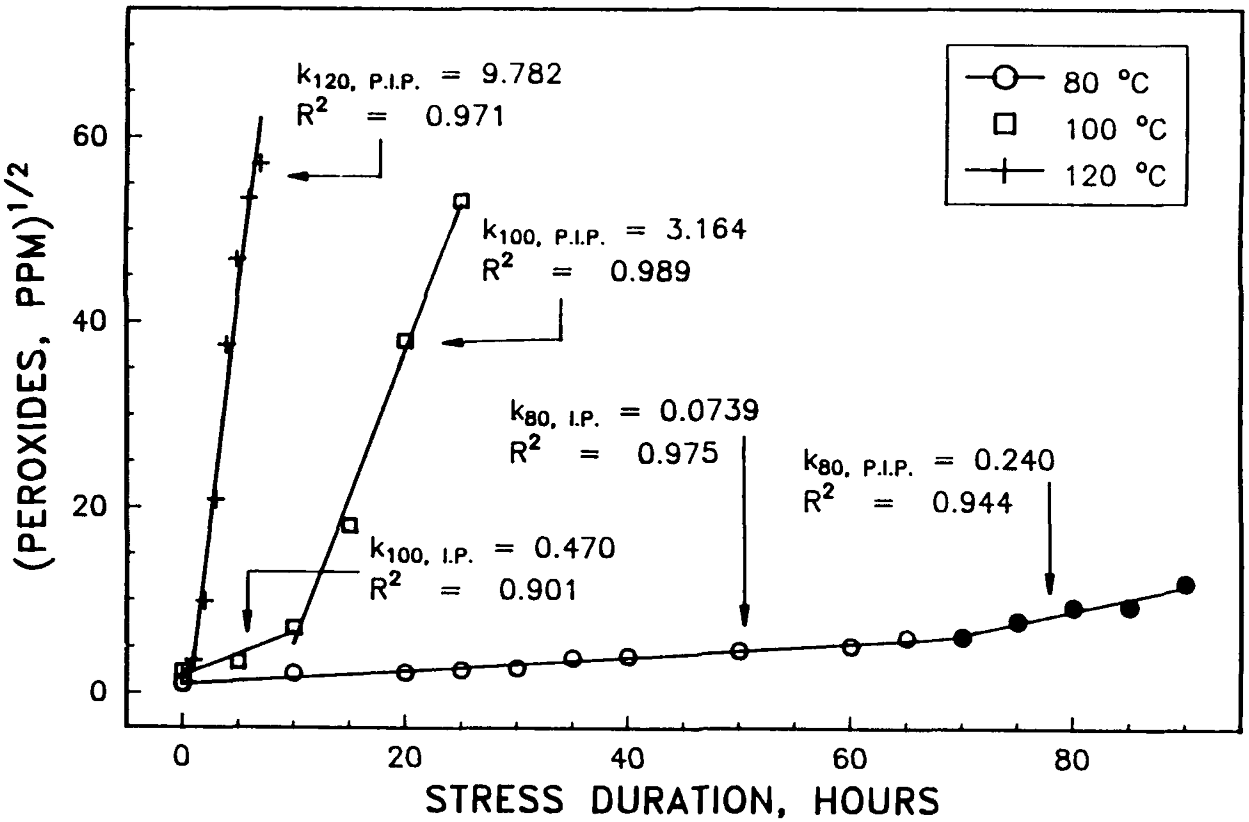


Figure 14.
ARRHENIUS PLOT OF OXIDATION OF FUELS 15708 AND 16581

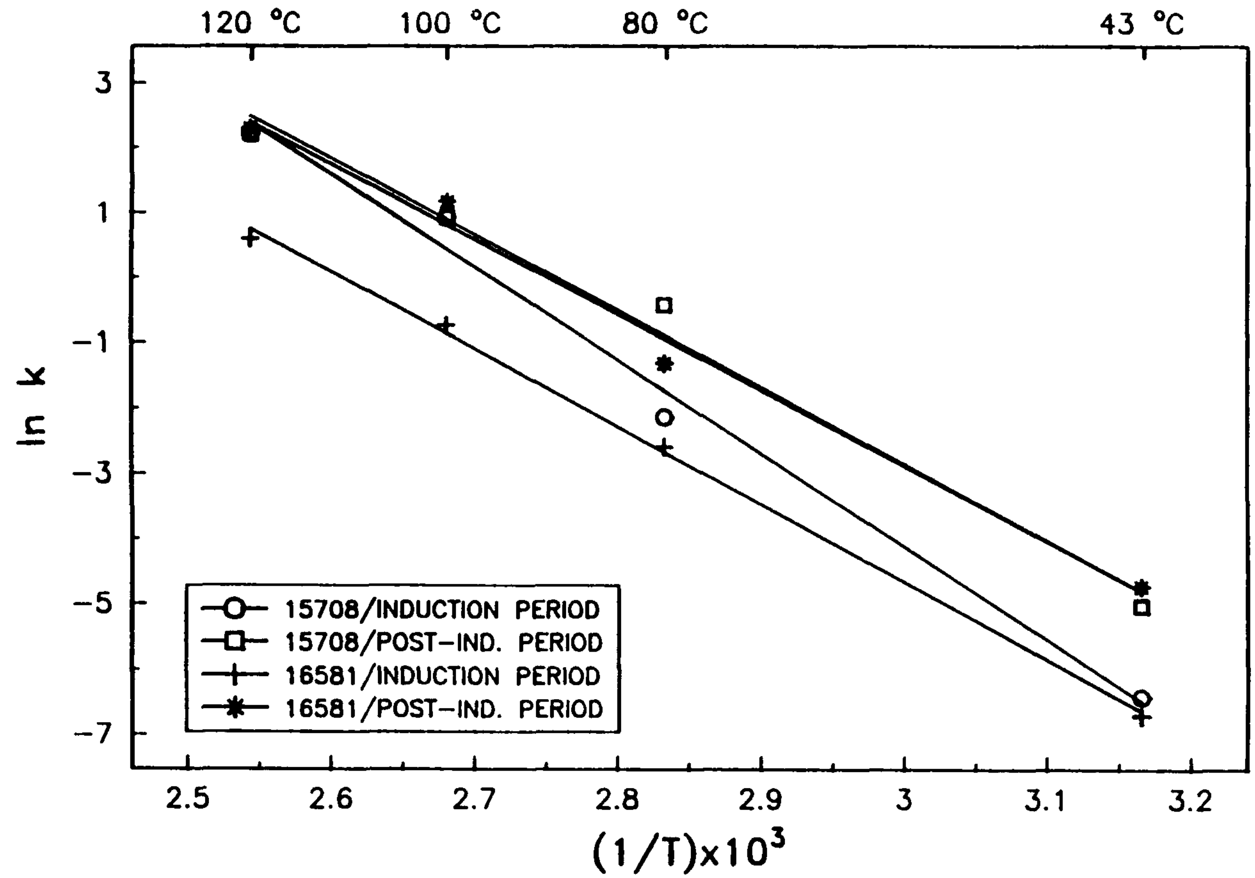
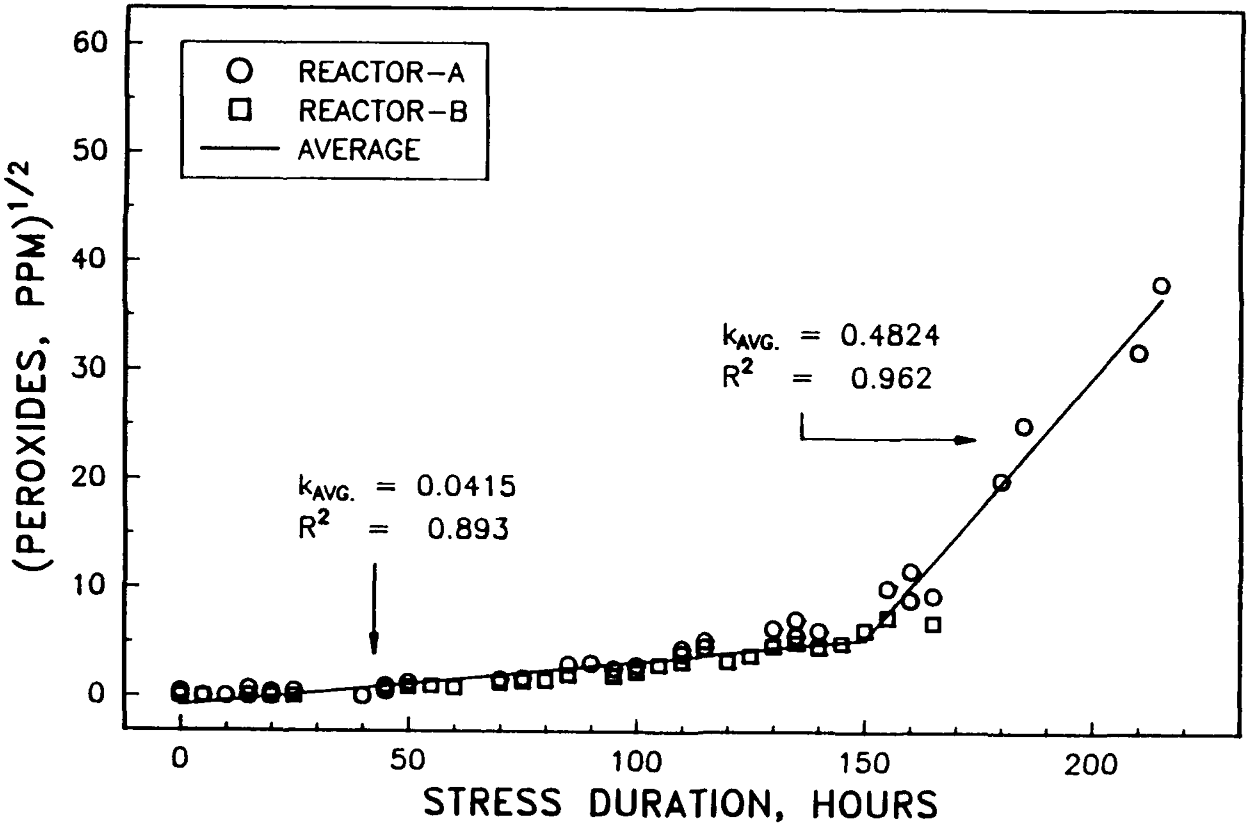


Figure 15. OXIDATION OF FUEL 18496
AT 80 °C UNDER 240 kPa OF OXYGEN



A02\PER01A.GRF

Figure 16. OXIDATION OF FUEL 18496 AT 100 °C UNDER 240 kPa OXYGEN

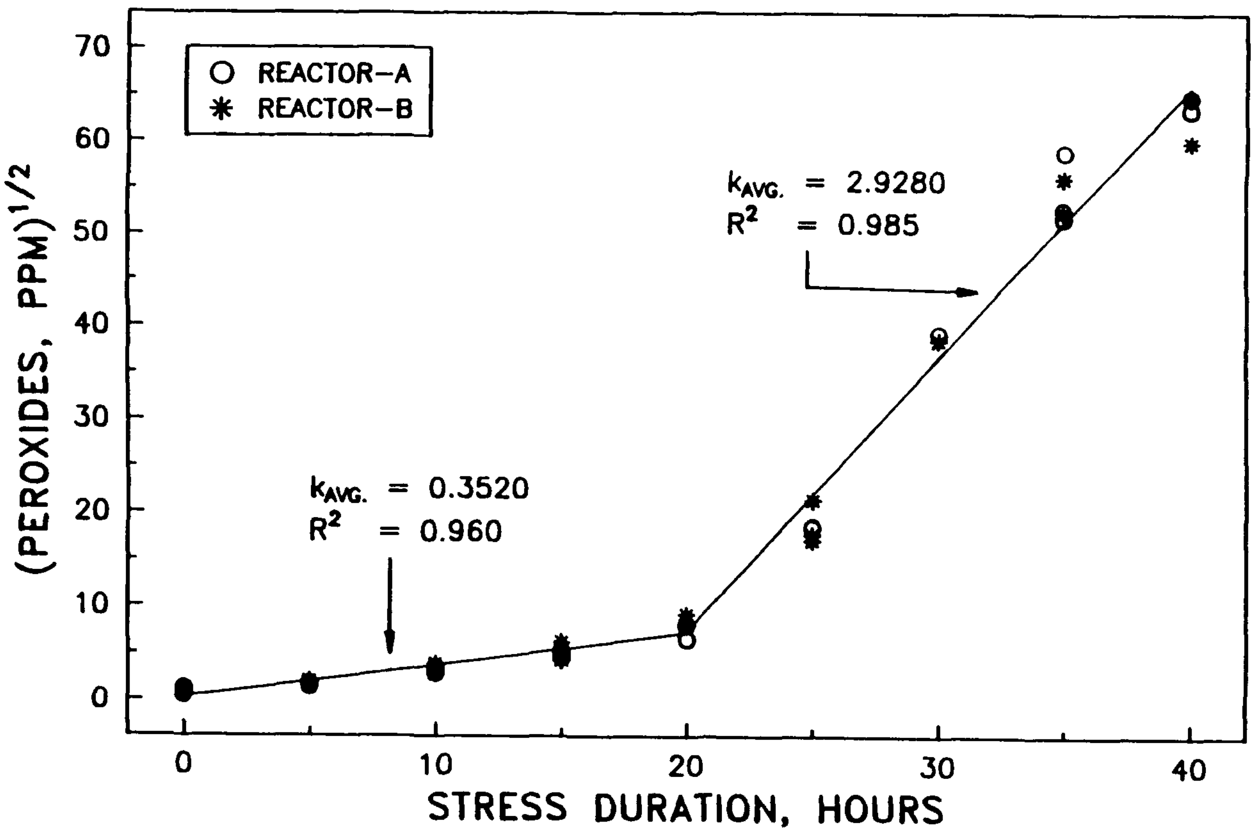


Figure 17. OXIDATION OF FUEL 18496
AT 120 °C UNDER 240 kPa OXYGEN

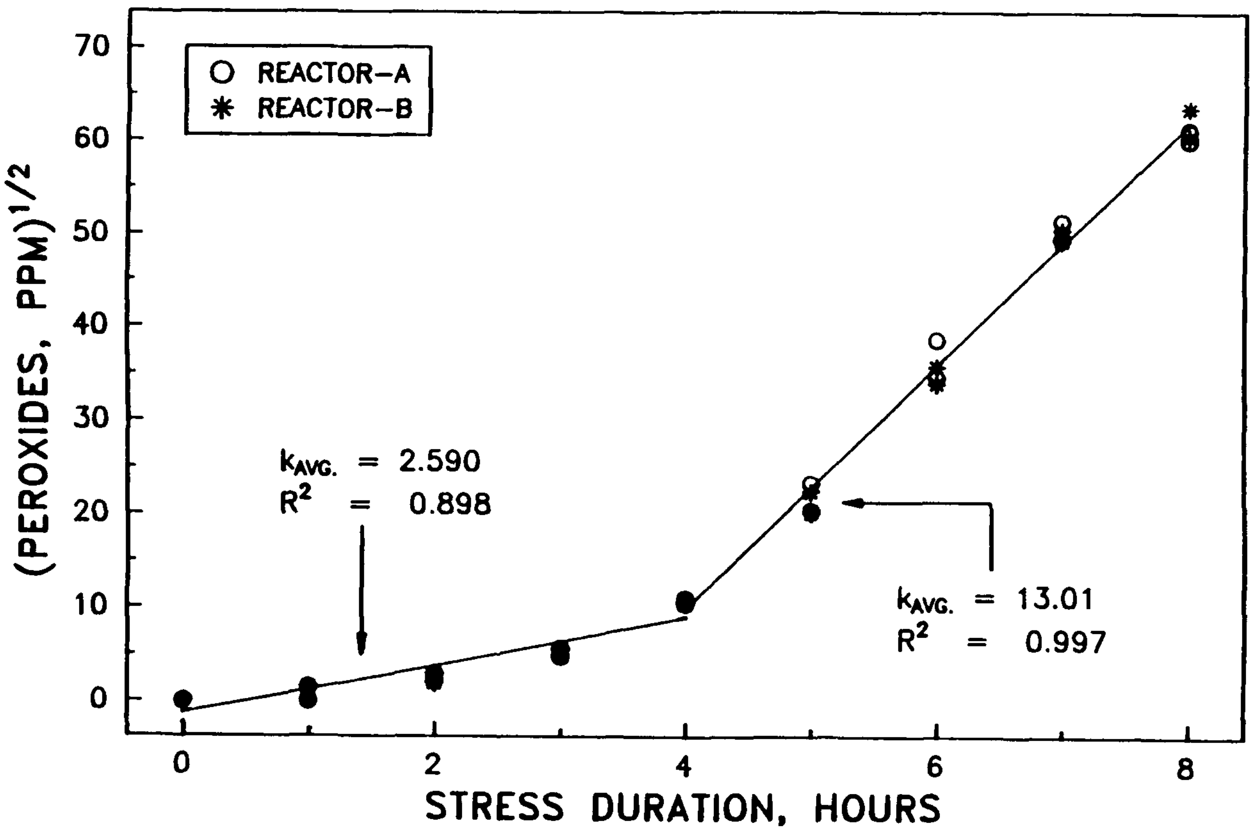
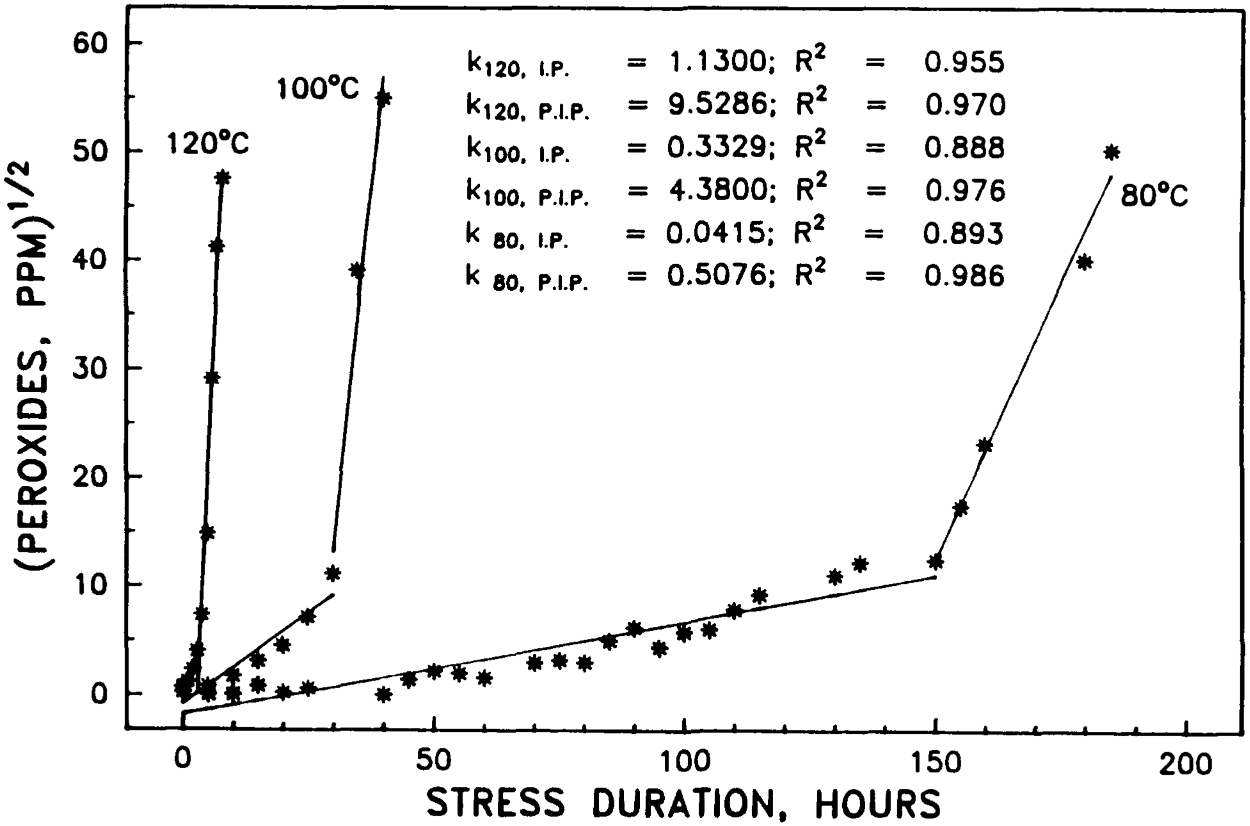


Figure 18. OXIDATION OF FUEL 18496
AT 80°, 100°, AND 120°C



PEROX2/PER20A.PLOT

Figure 19. OXIDATION OF FUEL 18497
AT 80 °C UNDER 240 kPa OF OXYGEN

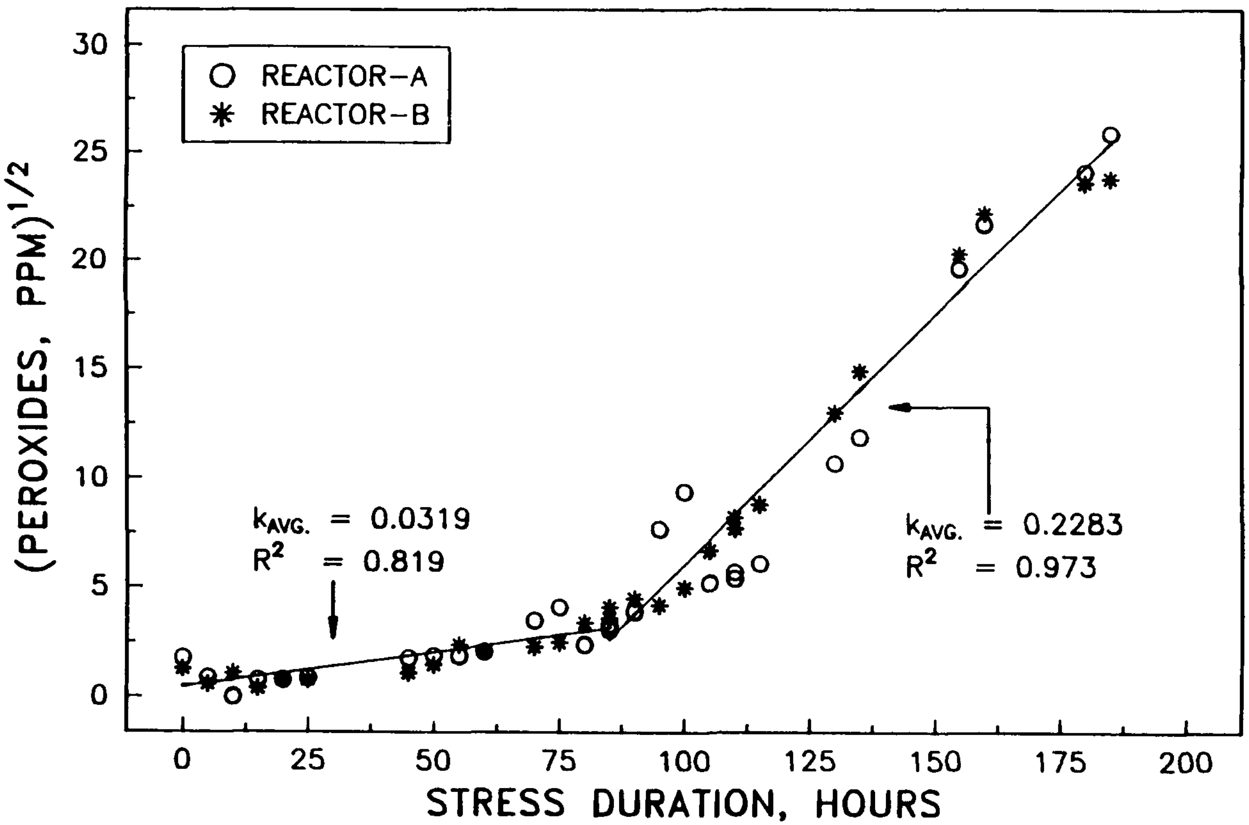
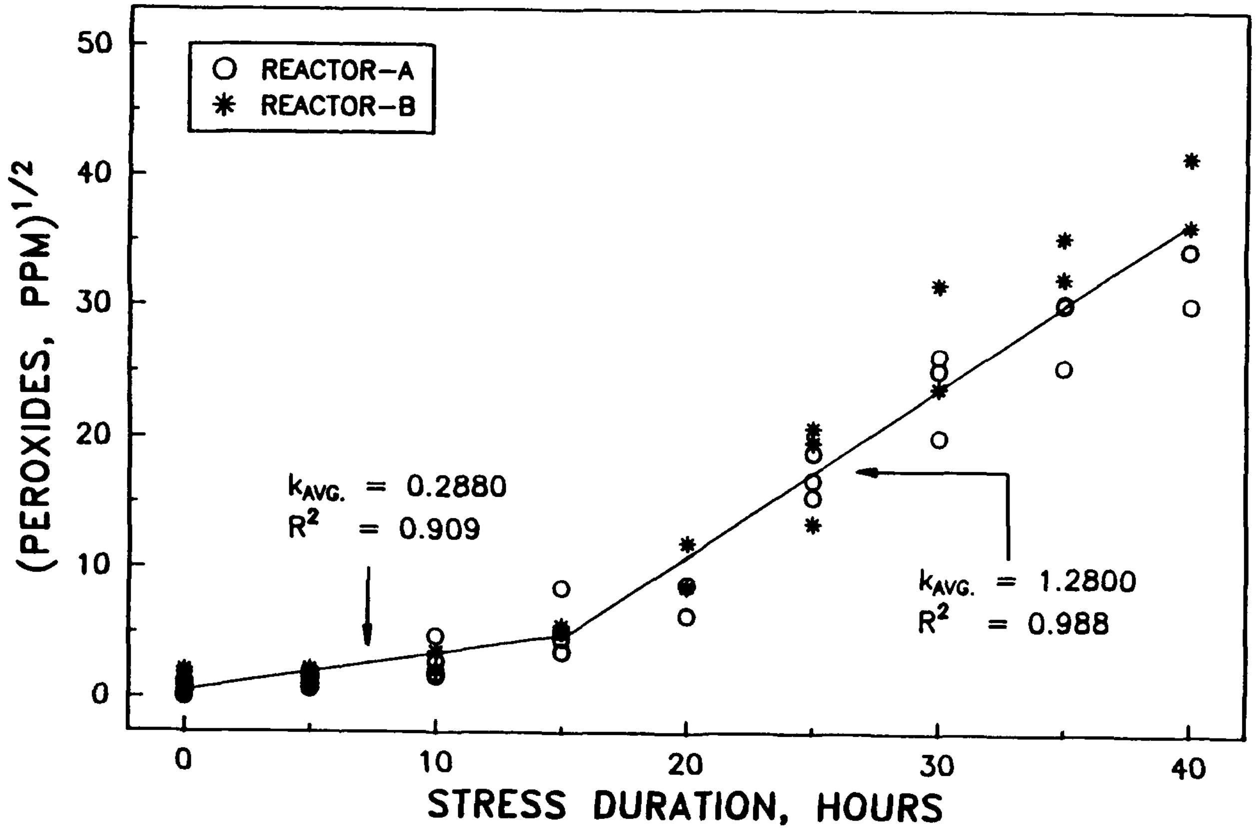


Figure 20. OXIDATION OF FUEL 18497
AT 100 °C UNDER 240 kPa OXYGEN



A01/PER25A.PLOT

Figure 21. OXIDATION OF FUEL 18497
AT 120°C UNDER 240 kPa OXYGEN

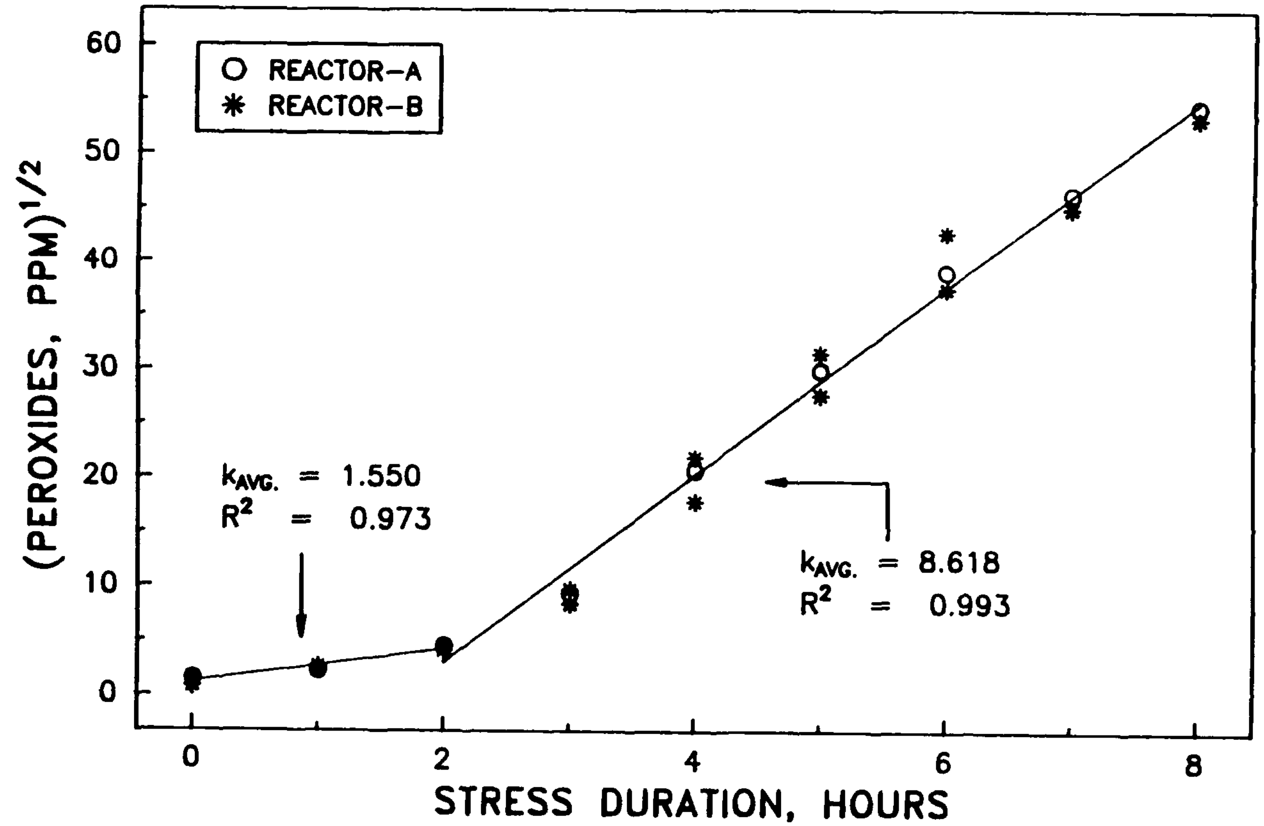
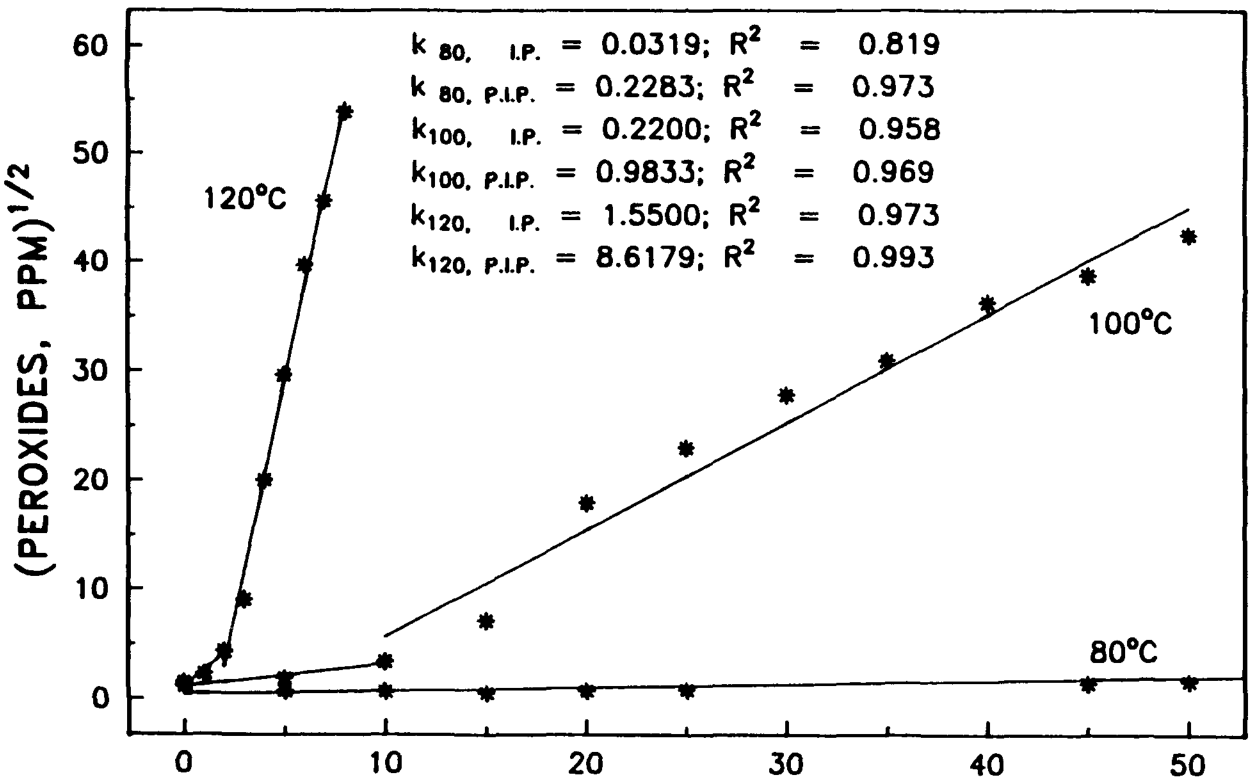
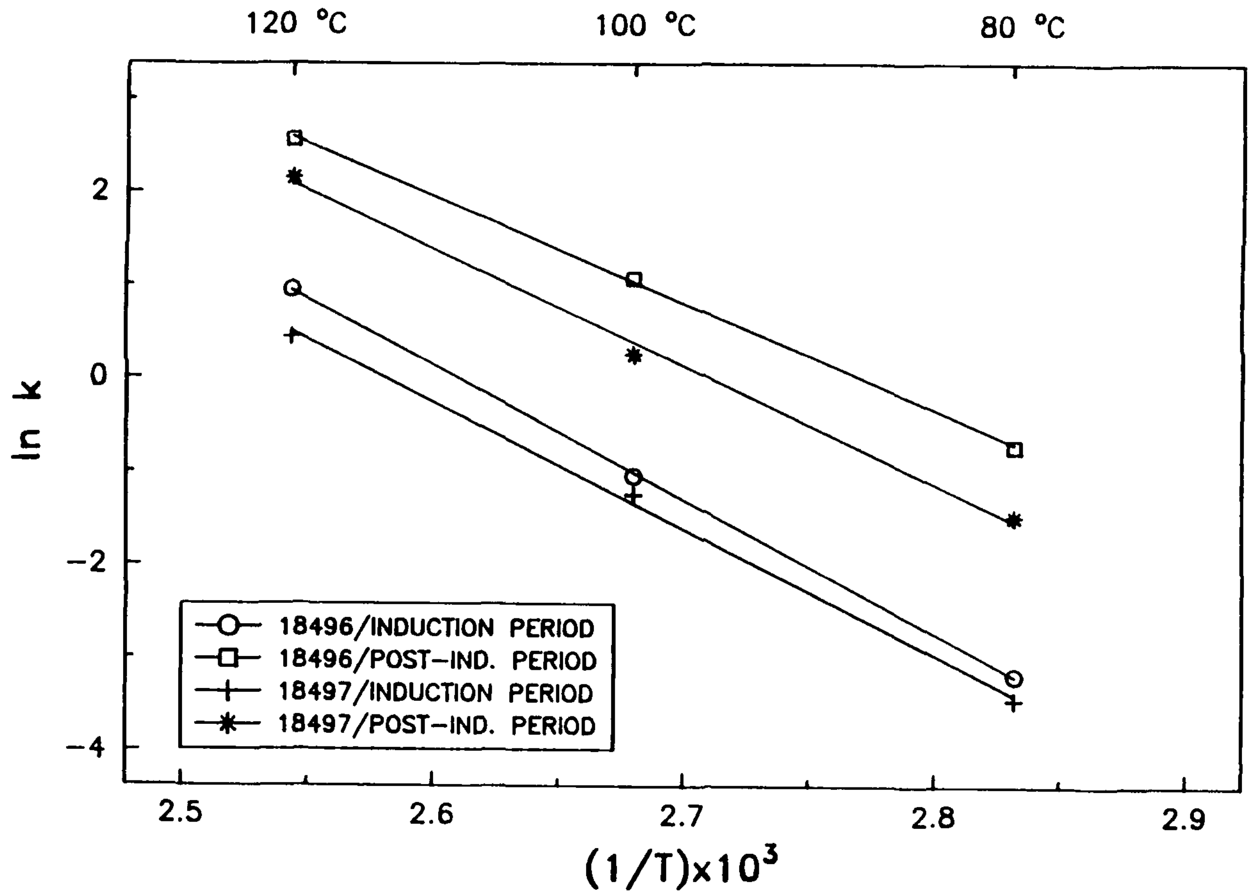


Figure 22. OXIDATION OF FUEL 18497
AT 80, 100, AND 120 °C



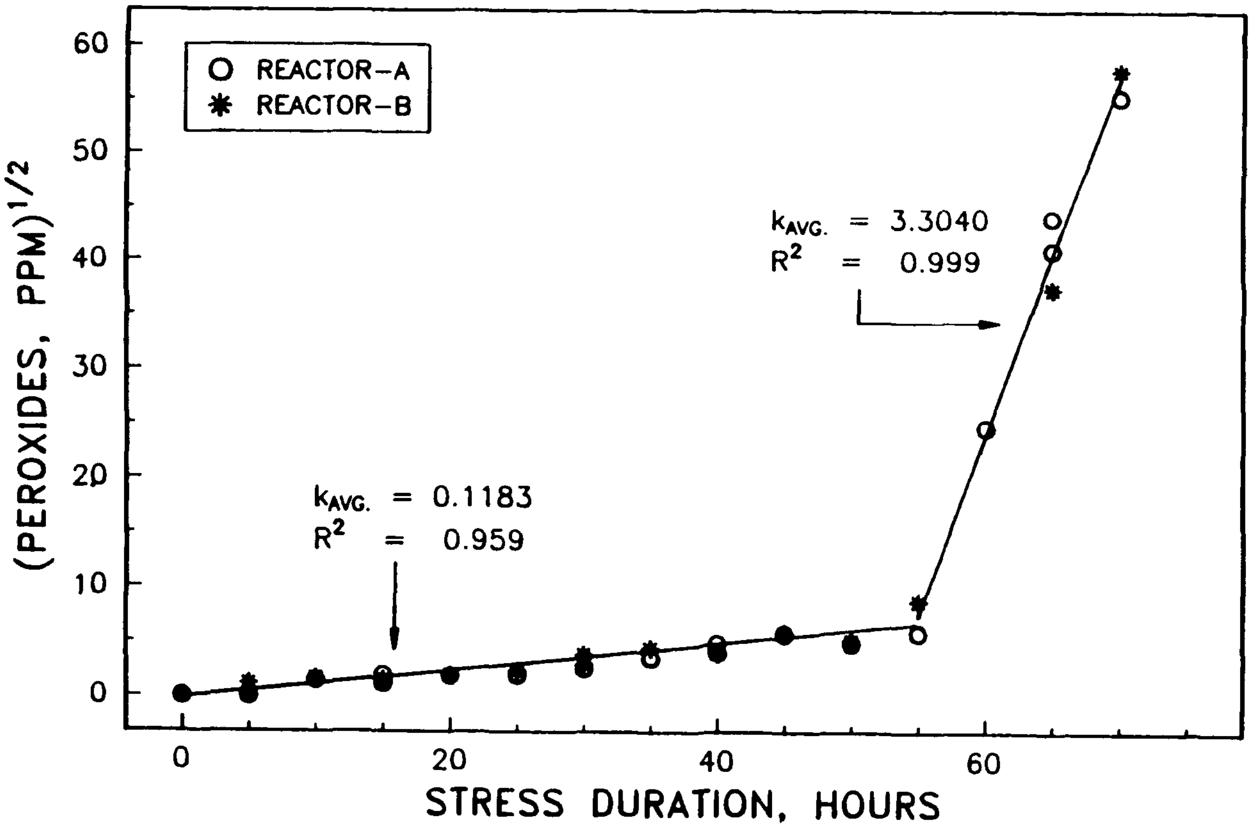
PEROX2/CARA01.PLOT

Figure 23.
ARRHENIUS PLOT OF OXIDATION OF FUELS 18496 AND 18497



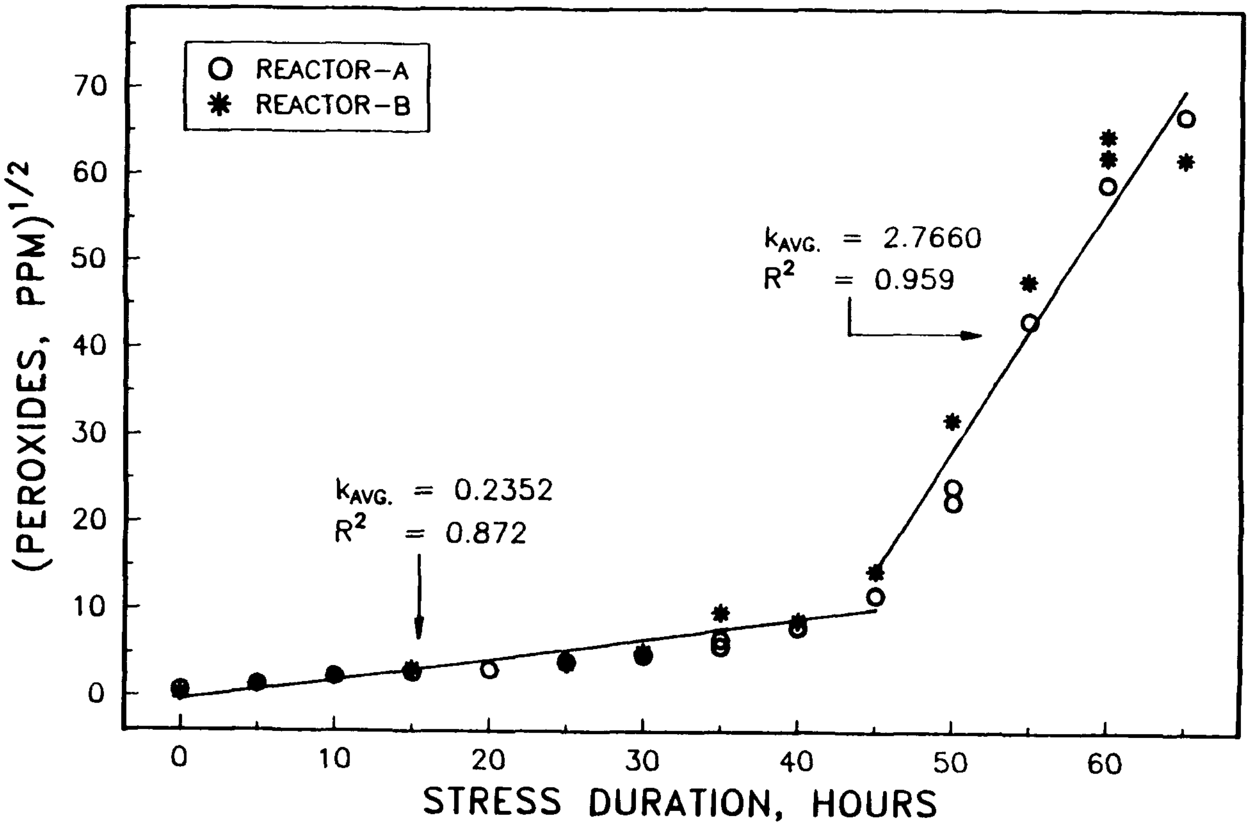
A02\PER03A.GRF

Figure 24.
OXIDATION AT 100 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "A"



A02\PER05A.GRF

Figure 25.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "B"



A02\PER07A.GRF

Figure 26.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "C"

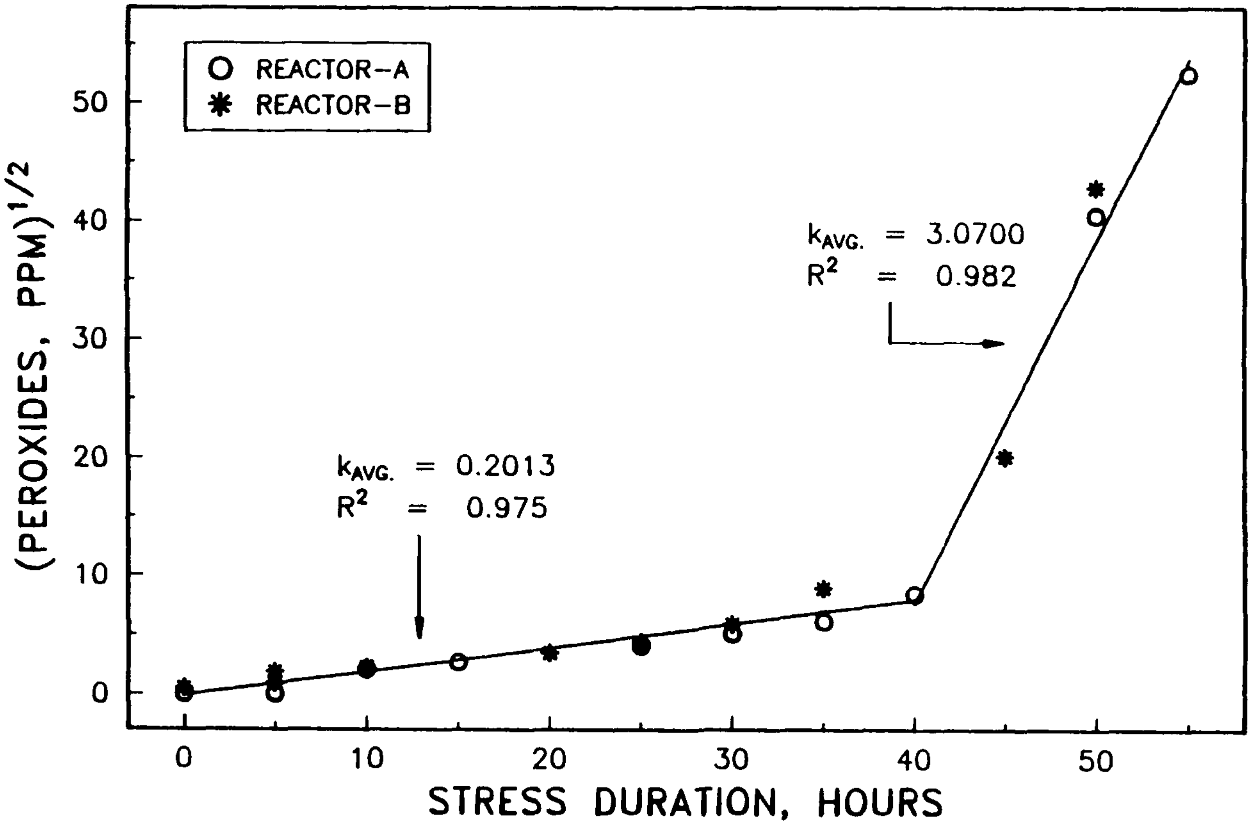
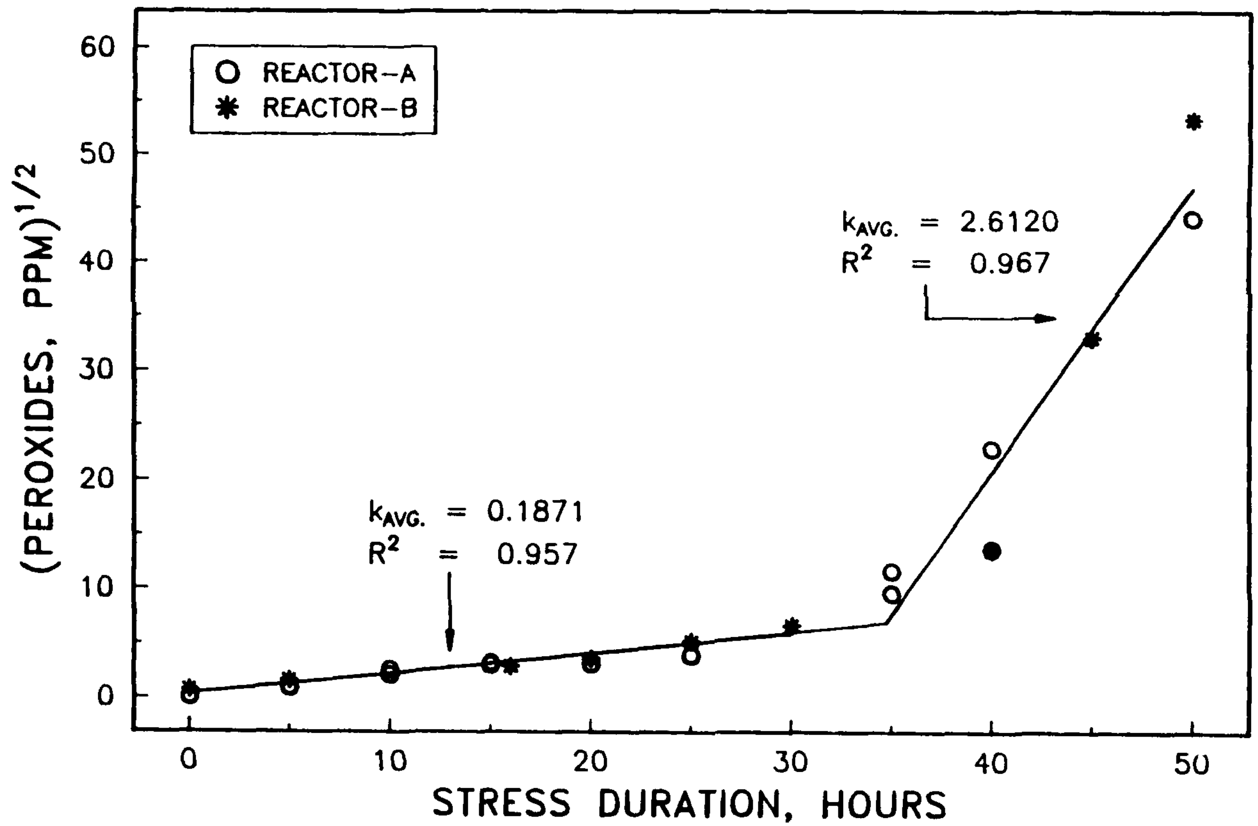
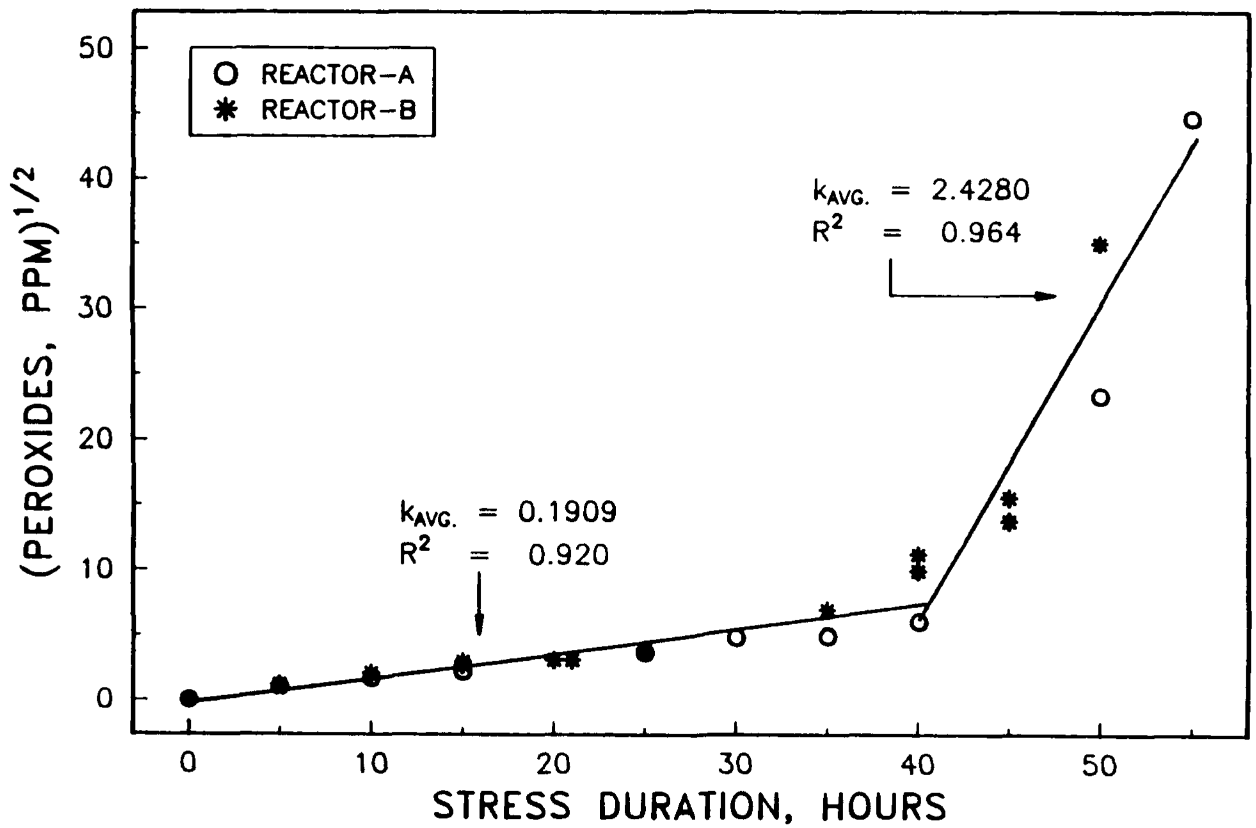


Figure 27.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "D"



A02\PER10A.GRF

Figure 28.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "E"



A02\PER11A.GRF

Figure 29.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "F"

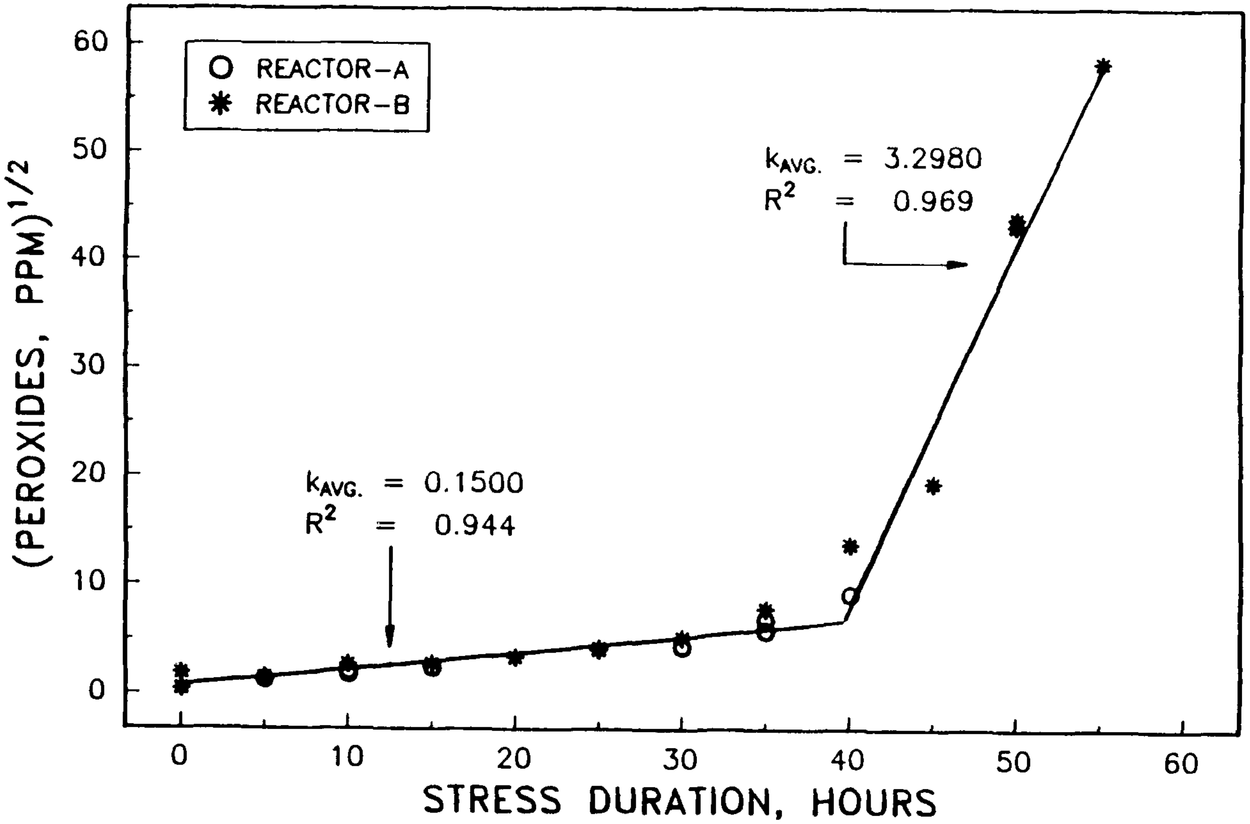


Figure 30.
OXIDATION AT 100 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "G"

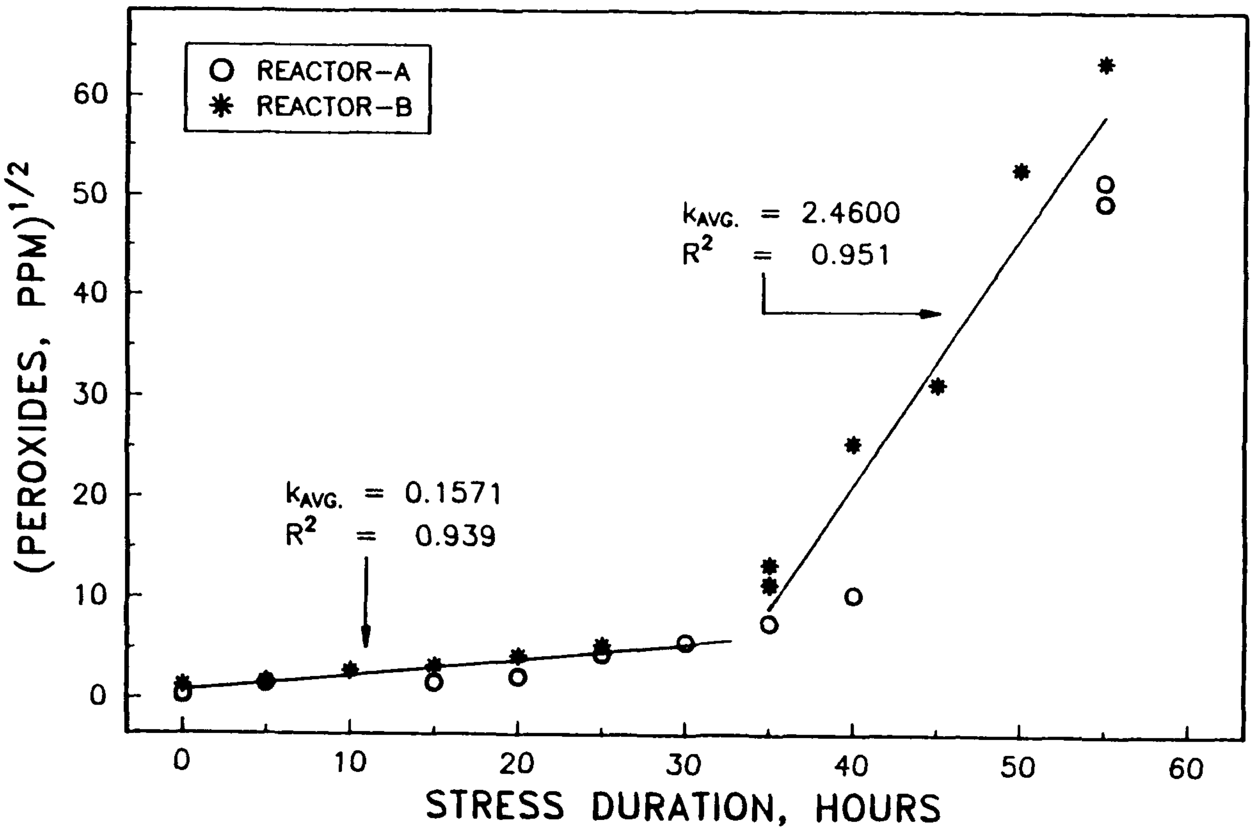
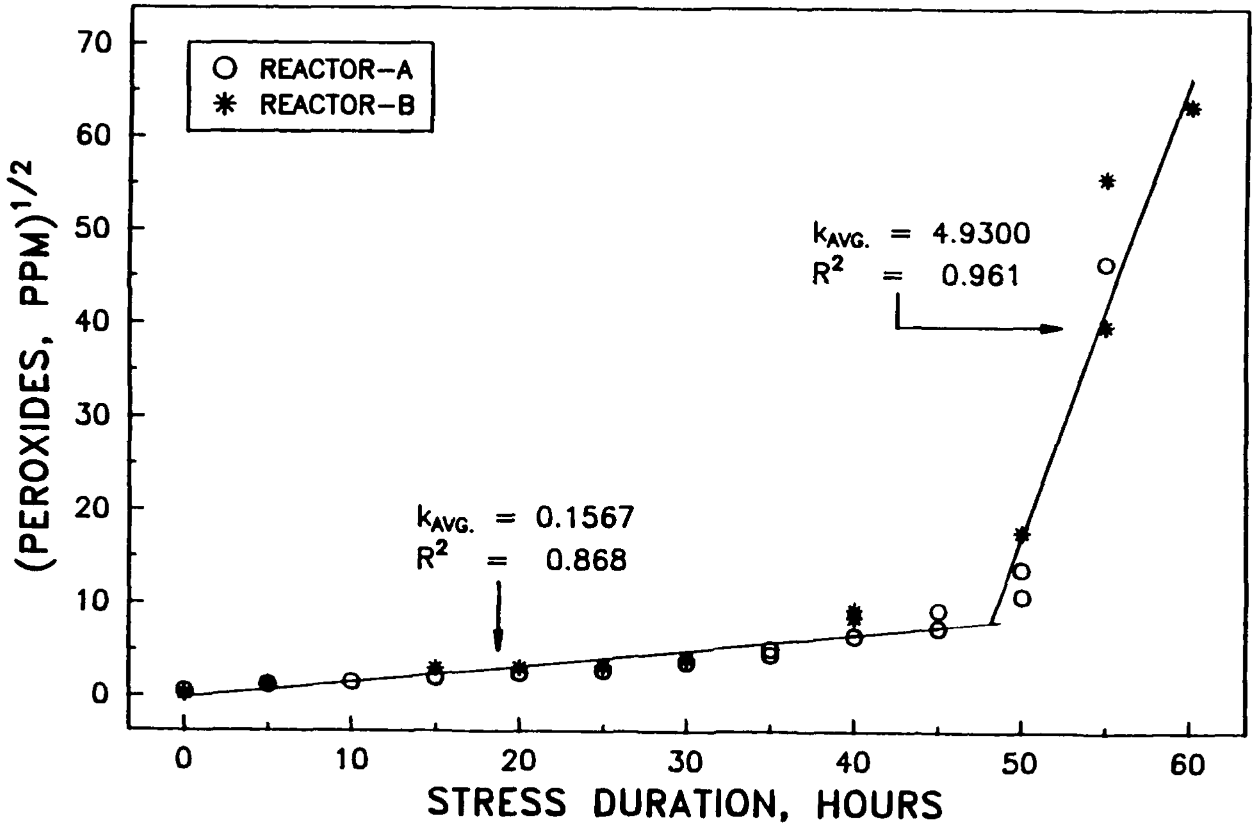
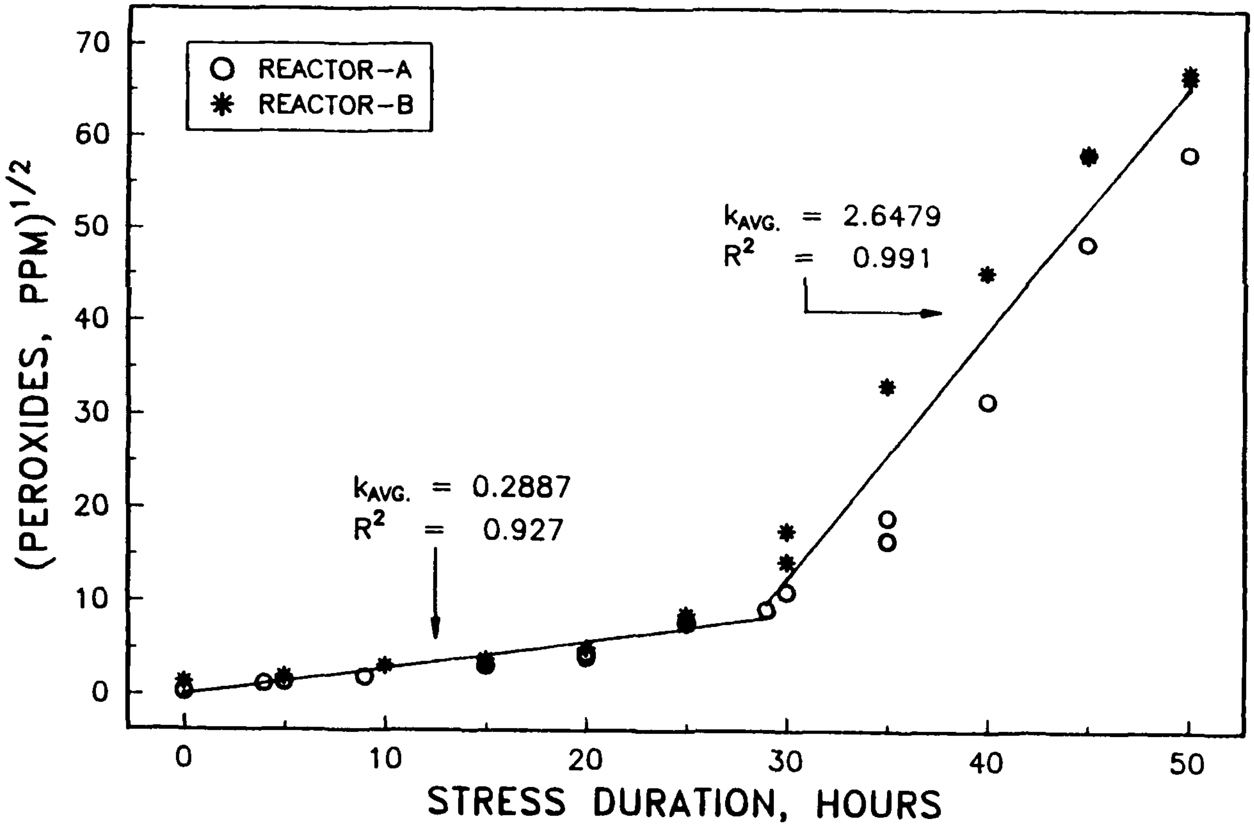


Figure 31.
OXIDATION AT 100 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "H"



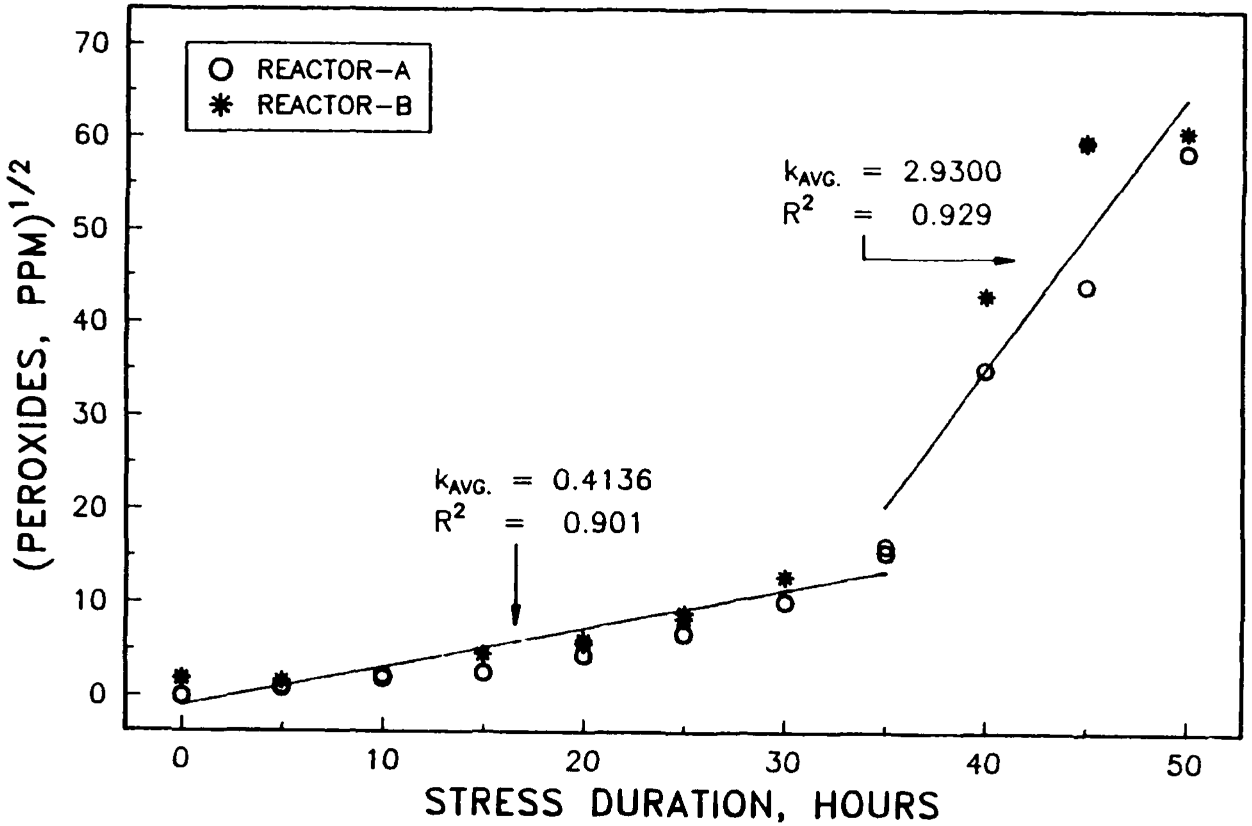
A02\PER14A.GRF

Figure 32.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "I"



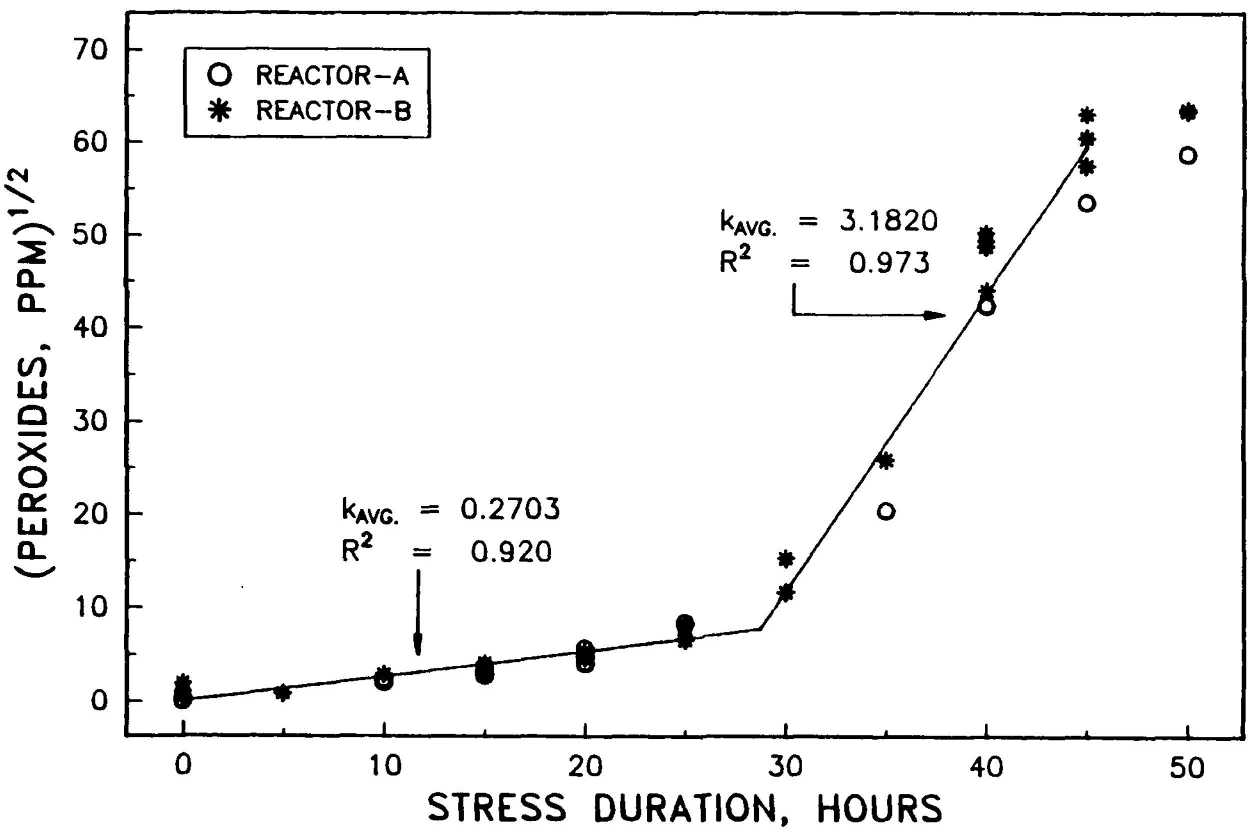
A02\PER15A.GRF

Figure 33.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "J"



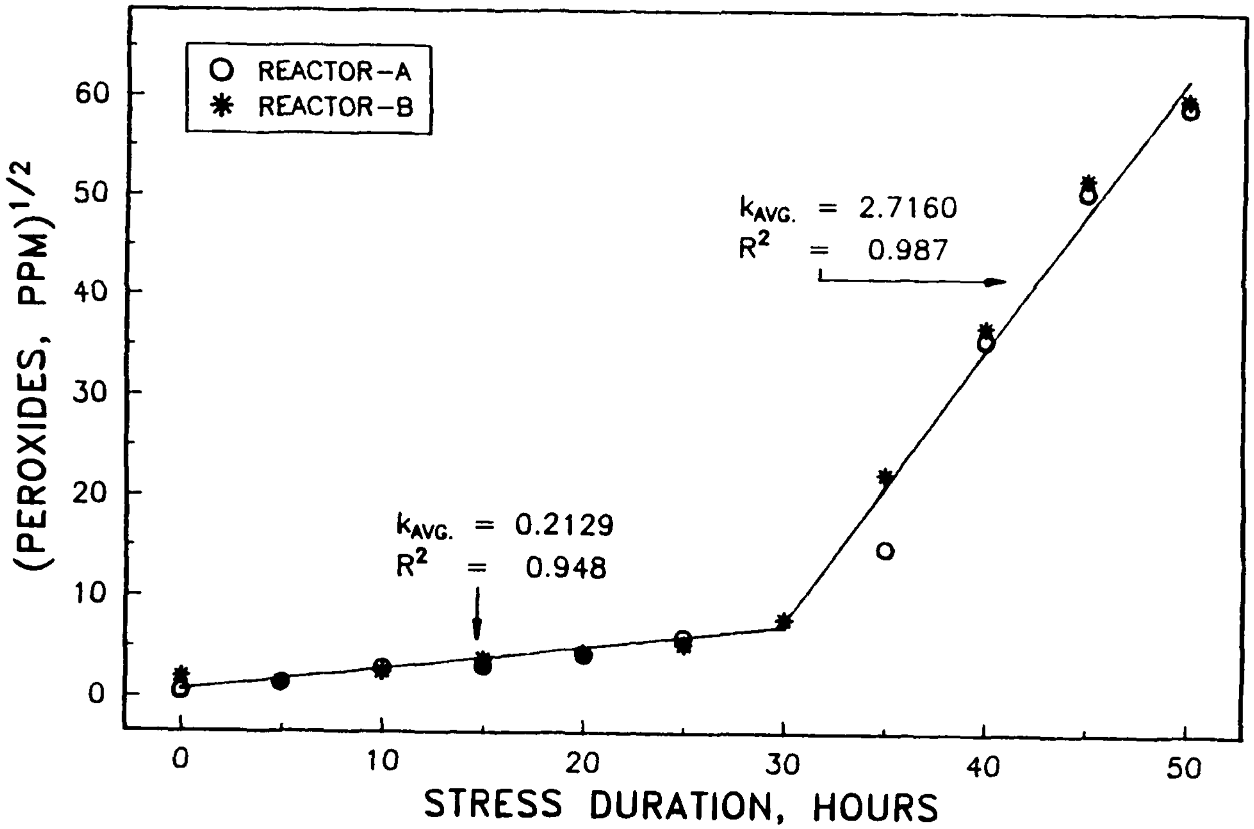
A02\PER16A.GRF

Figure 34.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "L"



A02\PER17A.GRF

Figure 35.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "M"



A02\PER18A.GRF

Figure 36.
OXIDATION AT 100 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "N"

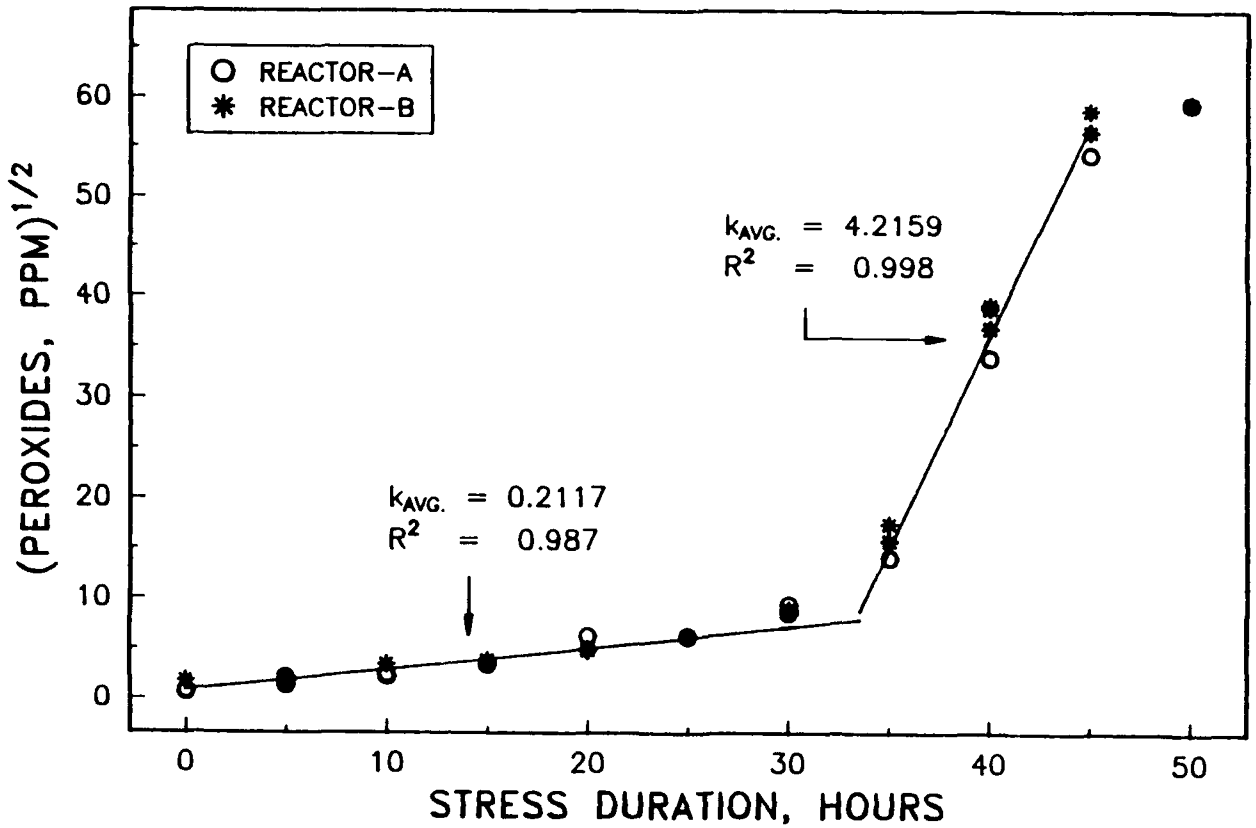
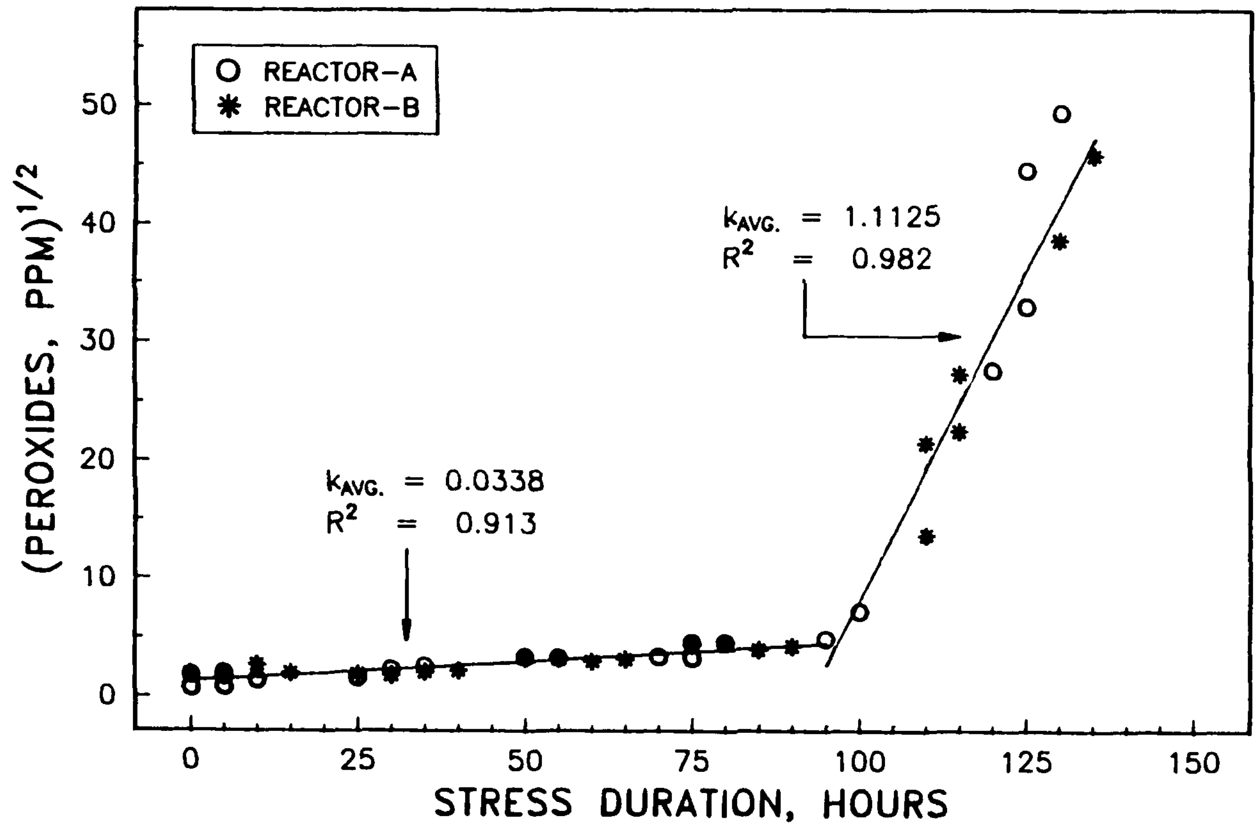
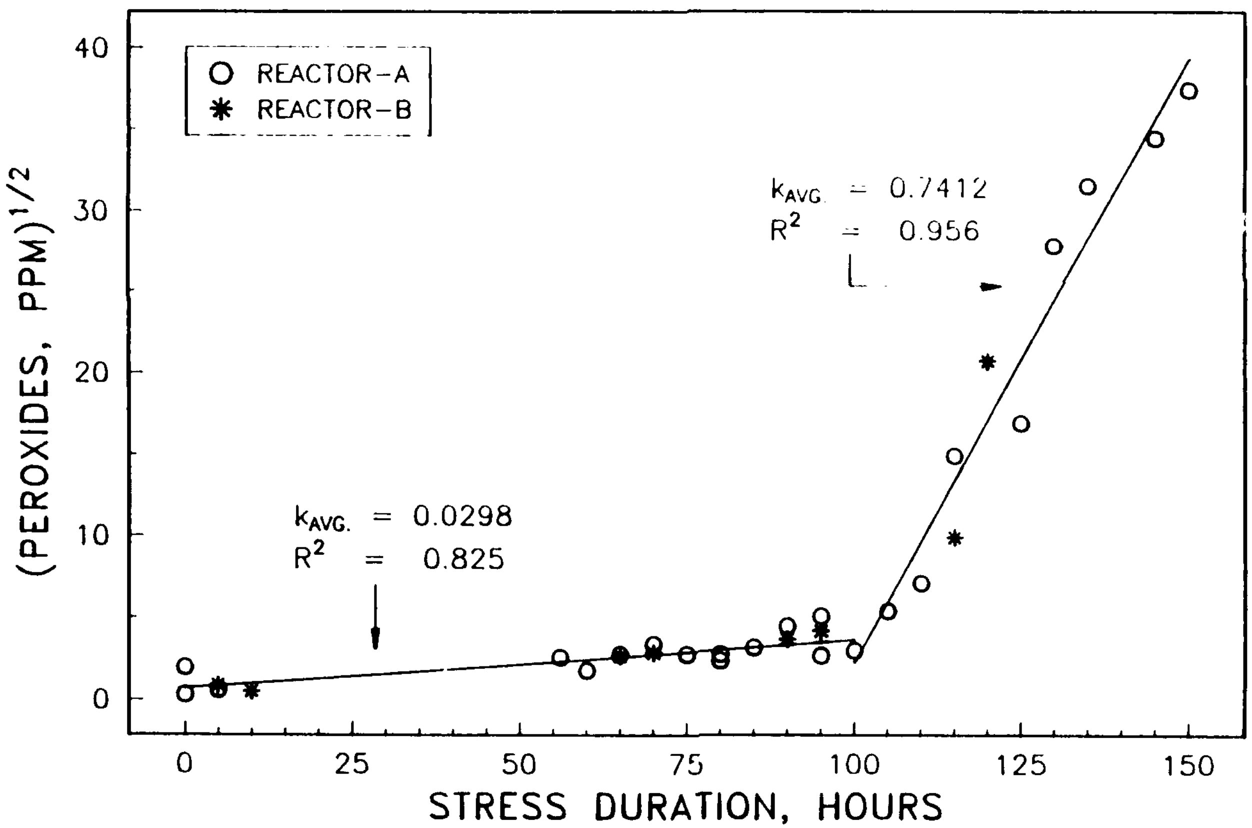


Figure 37.
OXIDATION AT 100 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "A"



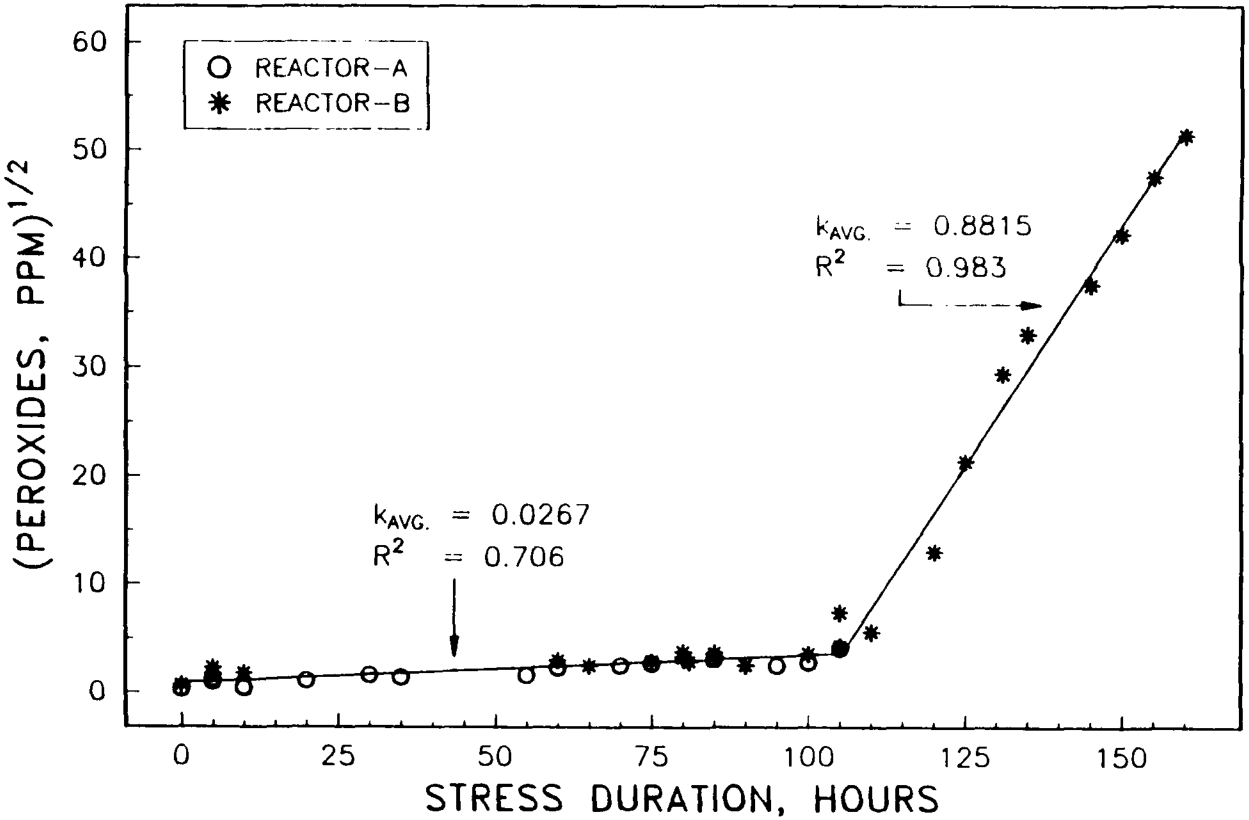
A02_PER06A.GRF

Figure 38.
OXIDATION AT 100 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "B"



A02 PEROBA.GRF

Figure 39.
OXIDATION AT 100 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "C"



A02 PER20A.GRF

Figure 40.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "D"

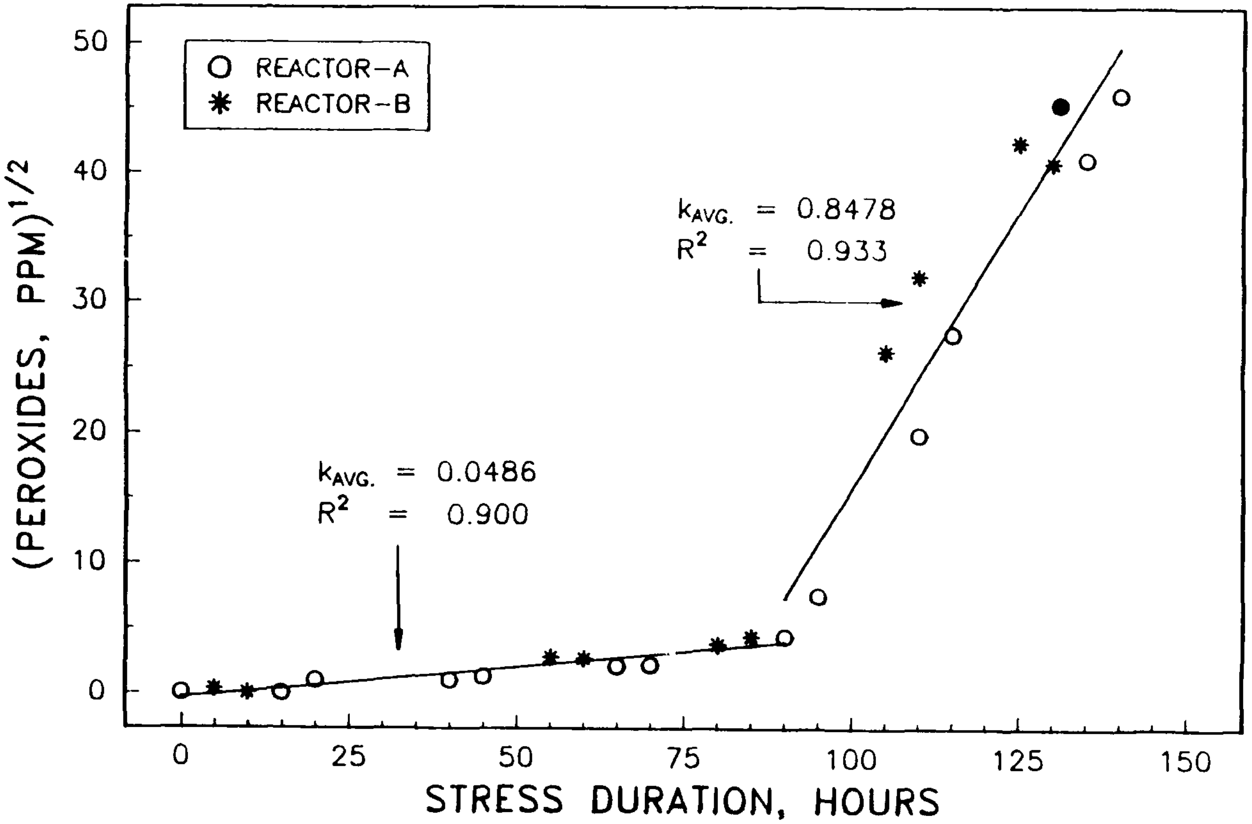


Figure 41.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "E"

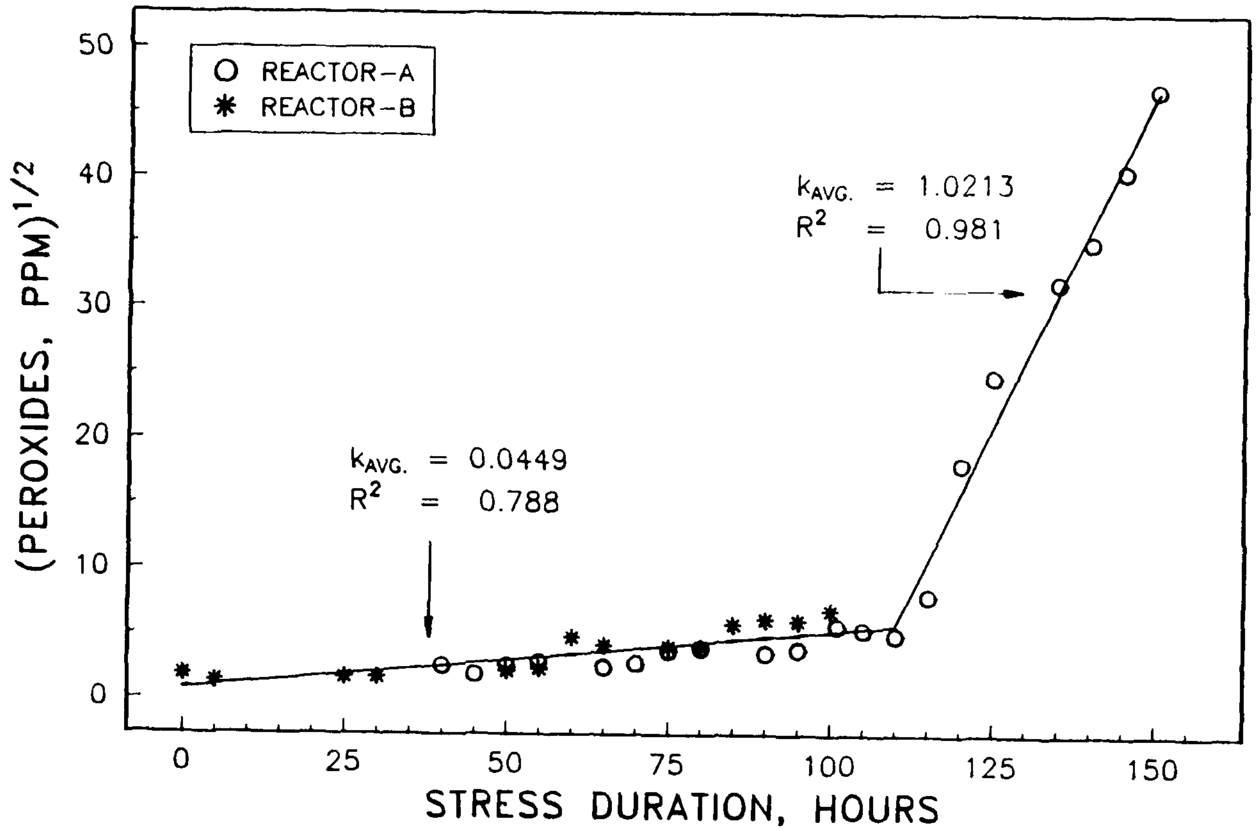
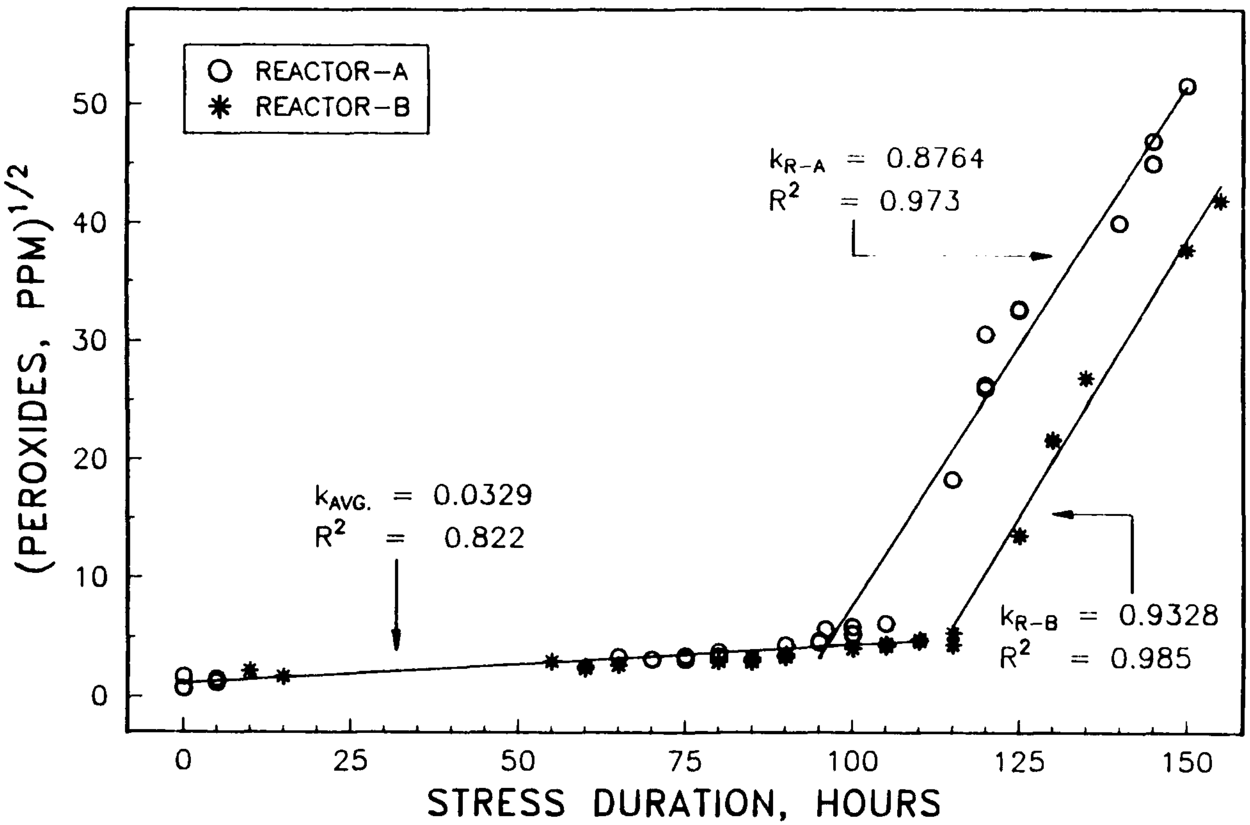
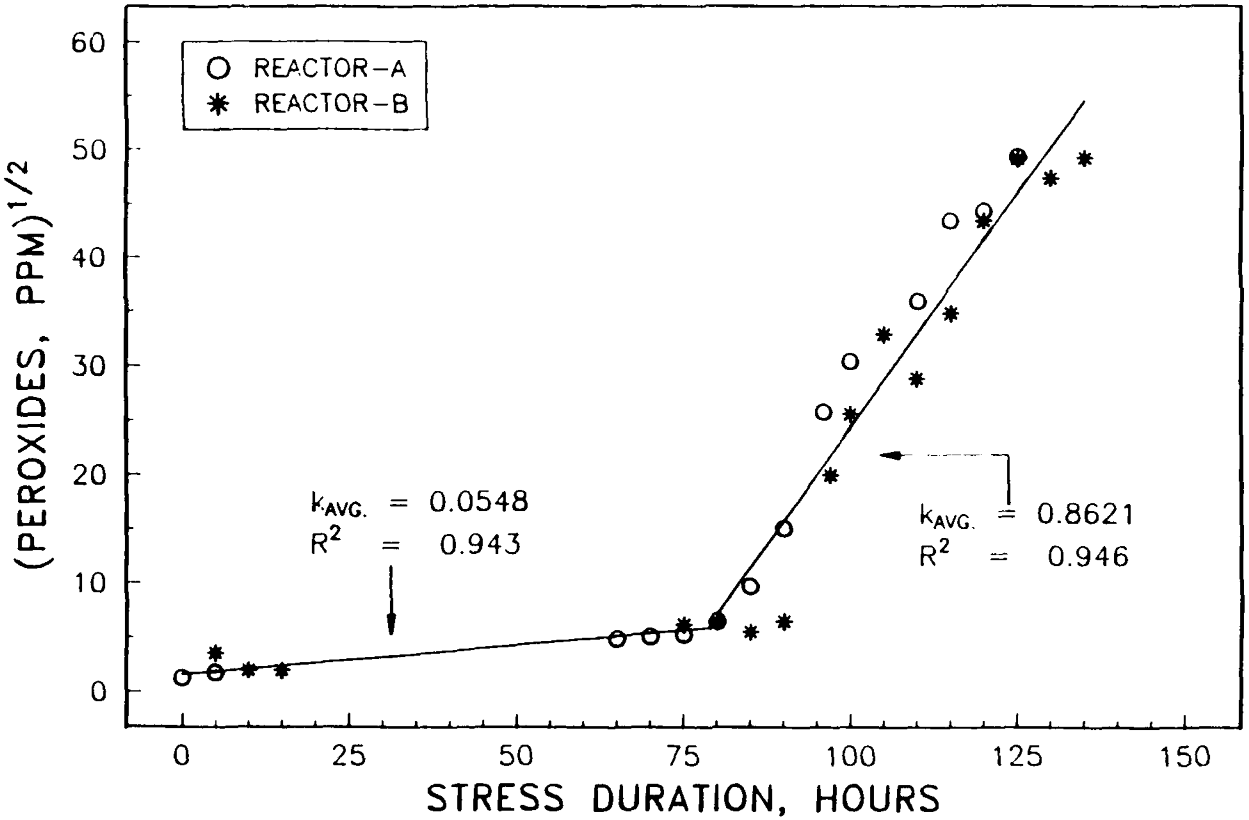


Figure 42.
OXIDATION AT 100 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "F"



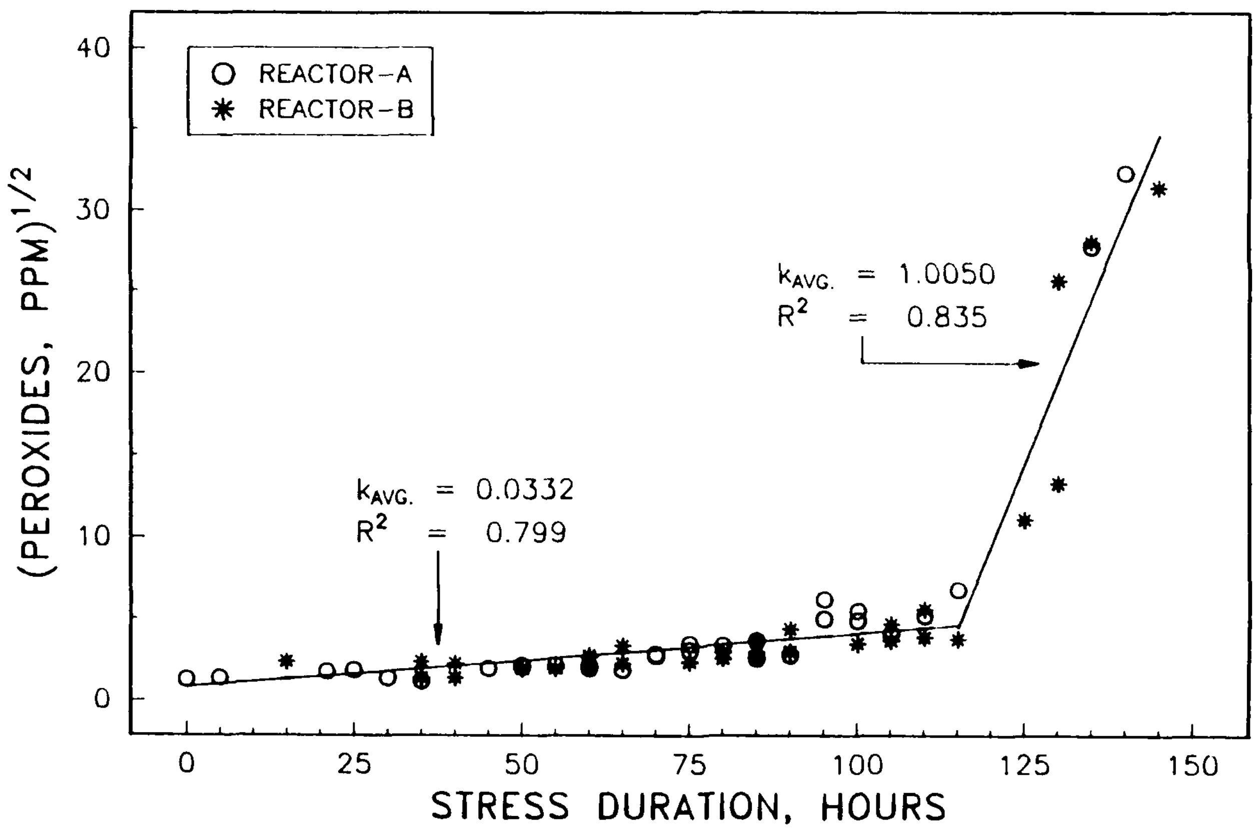
AO2`,PER23A.GRF

Figure 43.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "G"



A02\PER24A.GRF

Figure 44.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "H"



A02\PER25A.GRF

Figure 45.
OXIDATION AT 100 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "I"

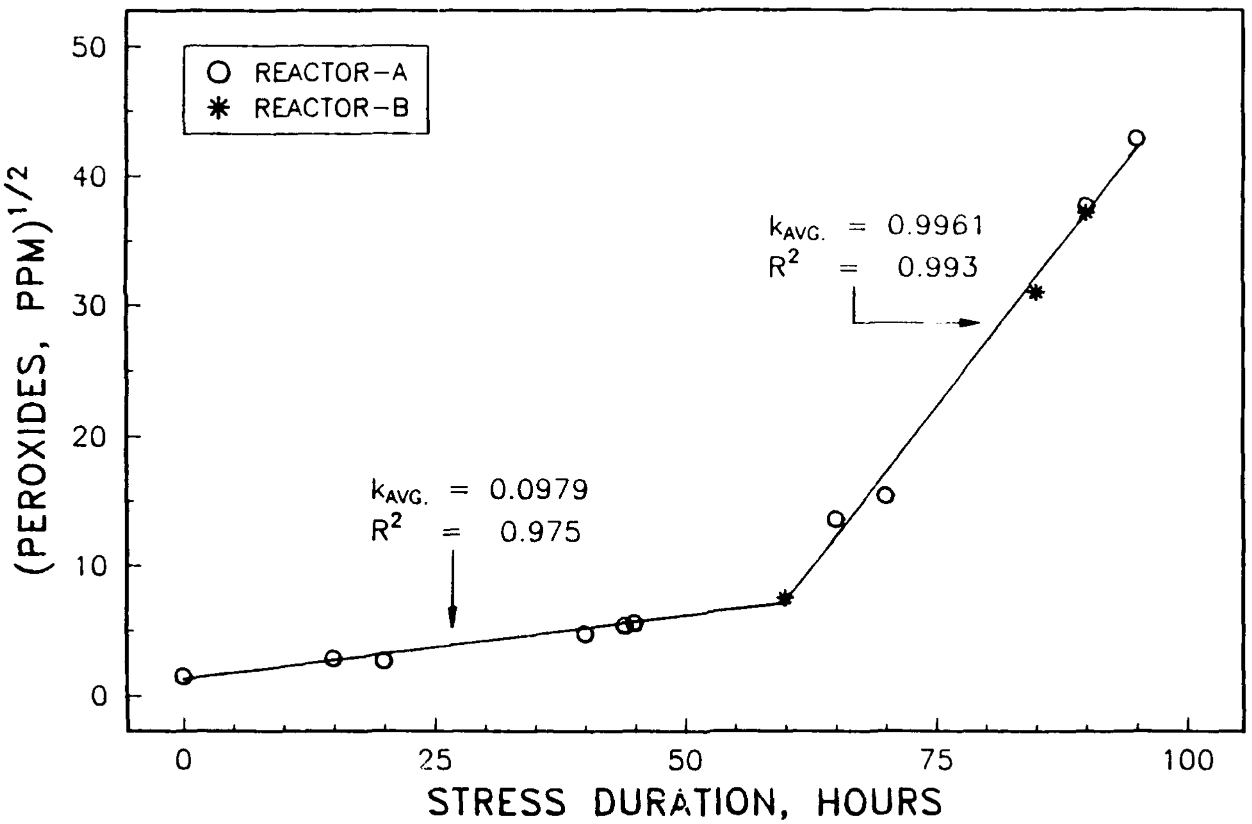


Figure 46.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "J"

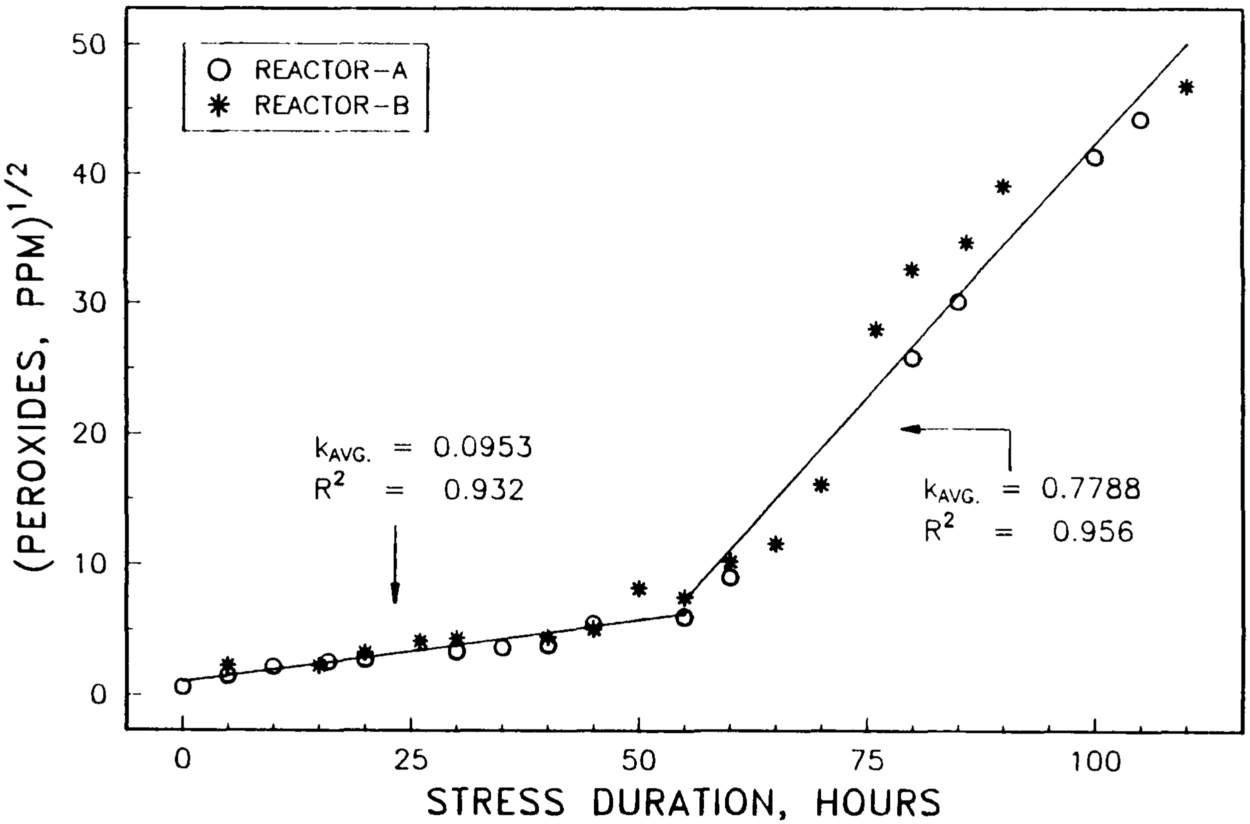
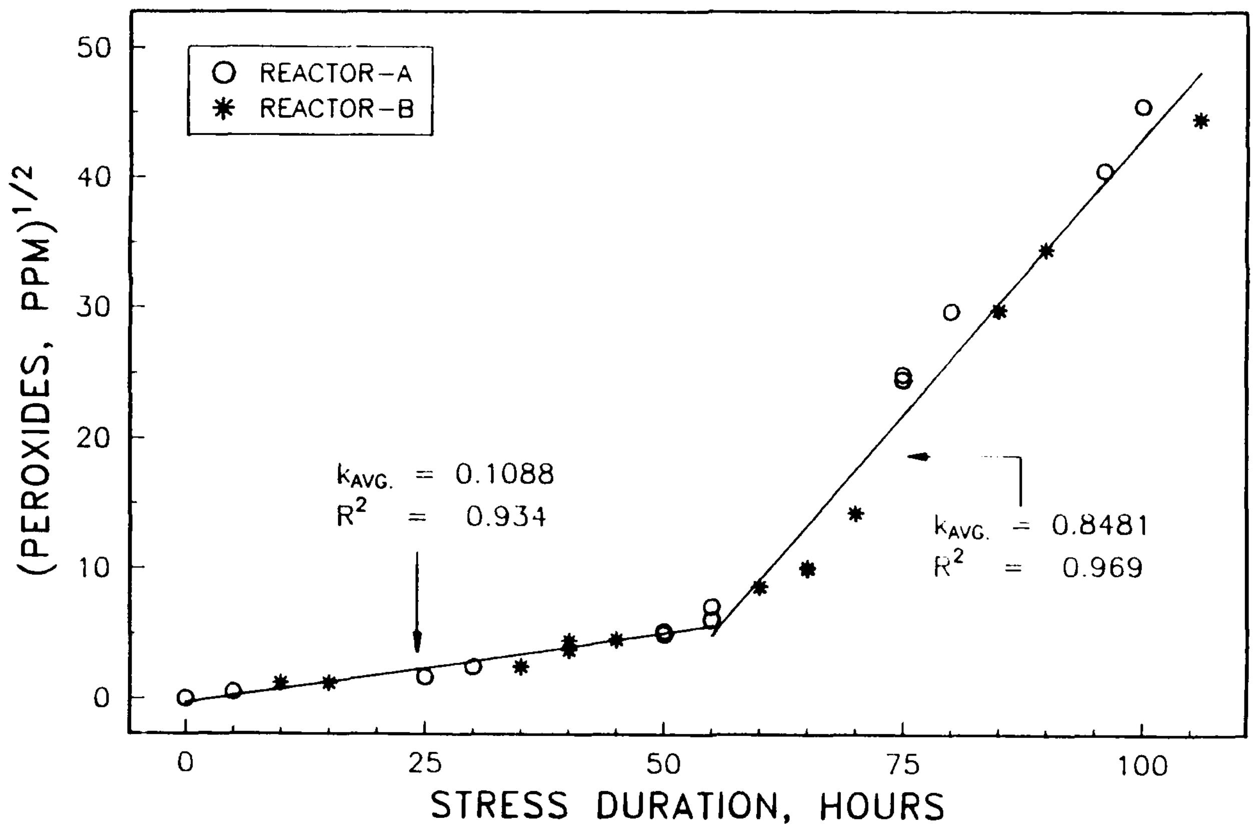
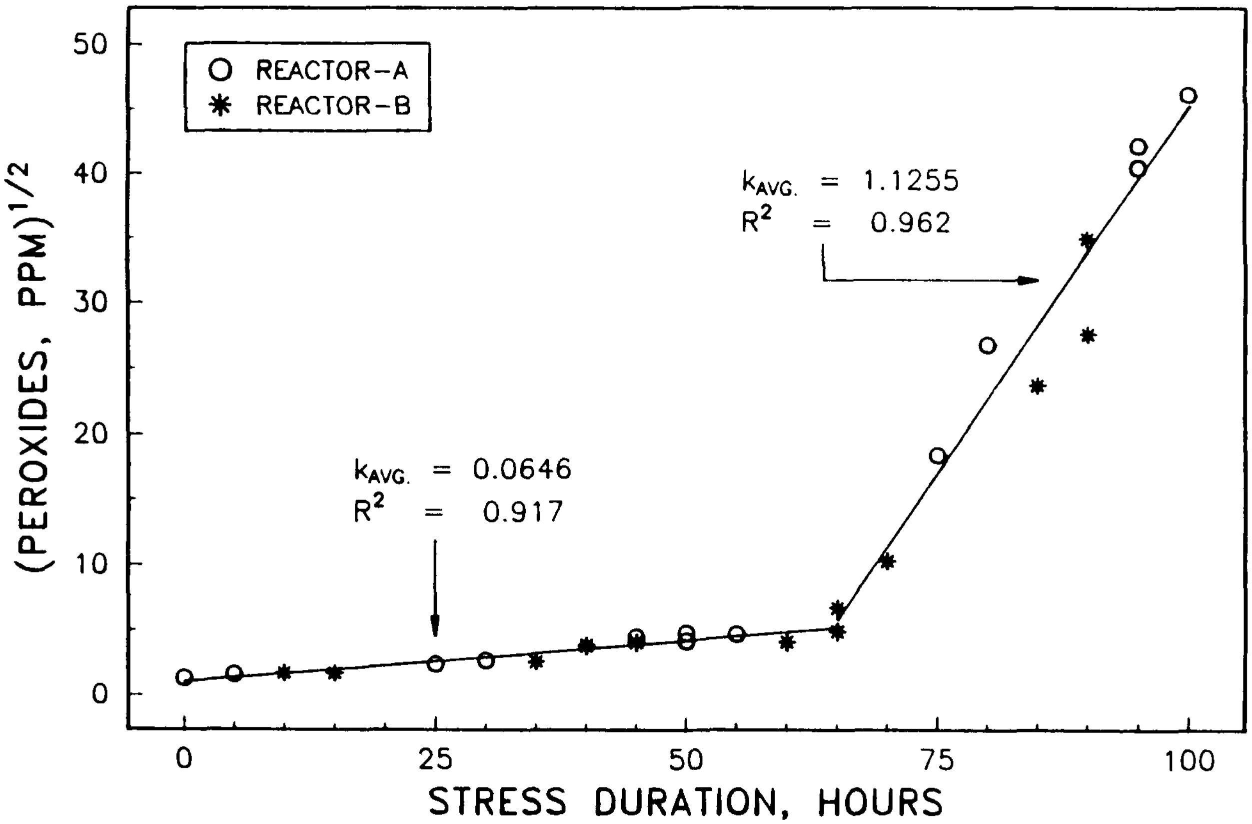


Figure 47.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "L"



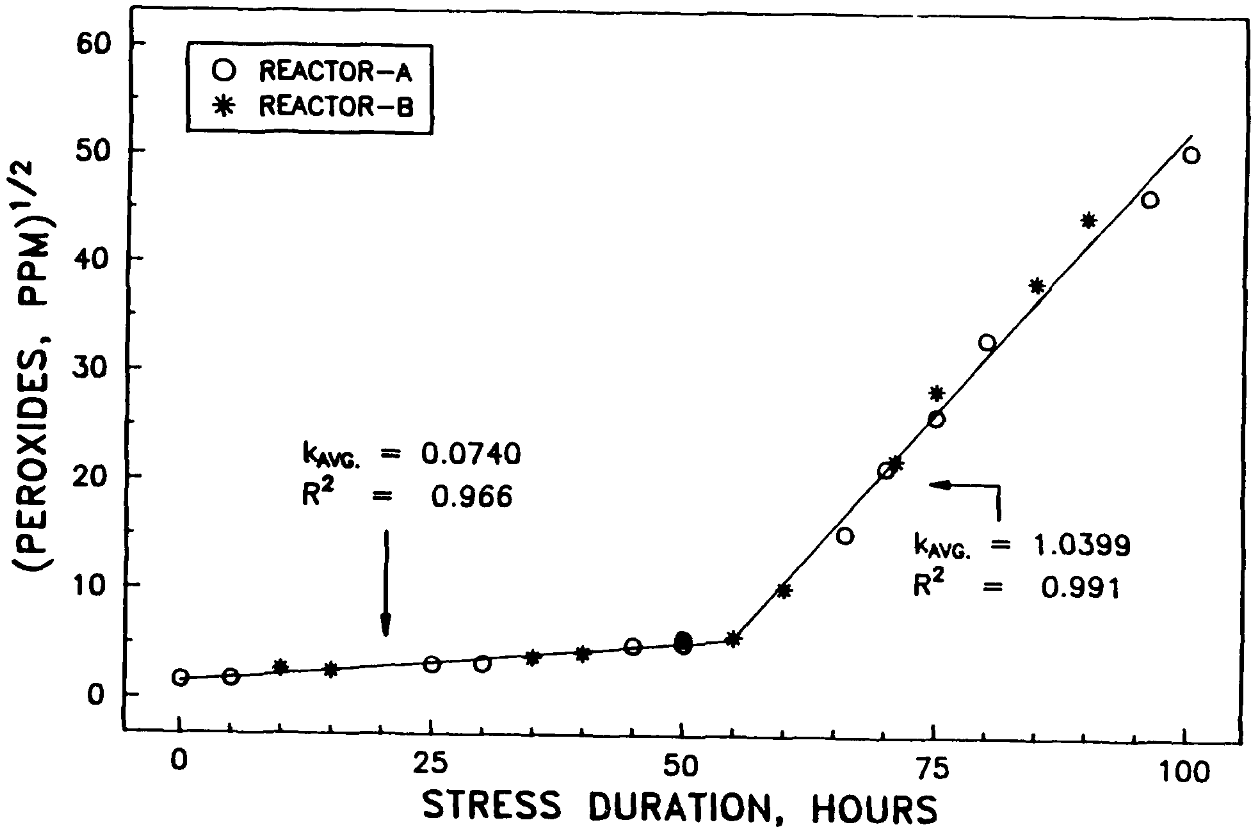
A02\PER28A.GRF

Figure 48.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "M"



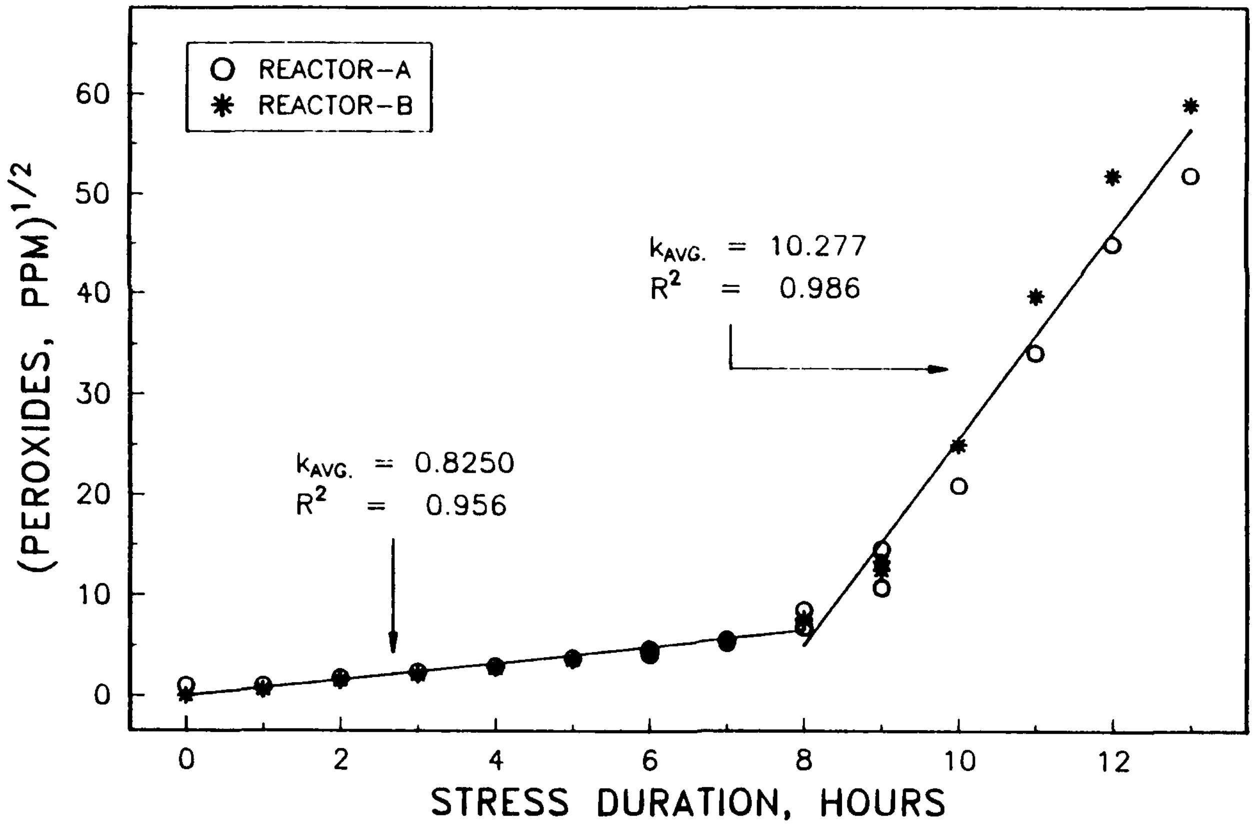
AO2\PER29A.GRF

Figure 49.
OXIDATION AT 100 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "N"



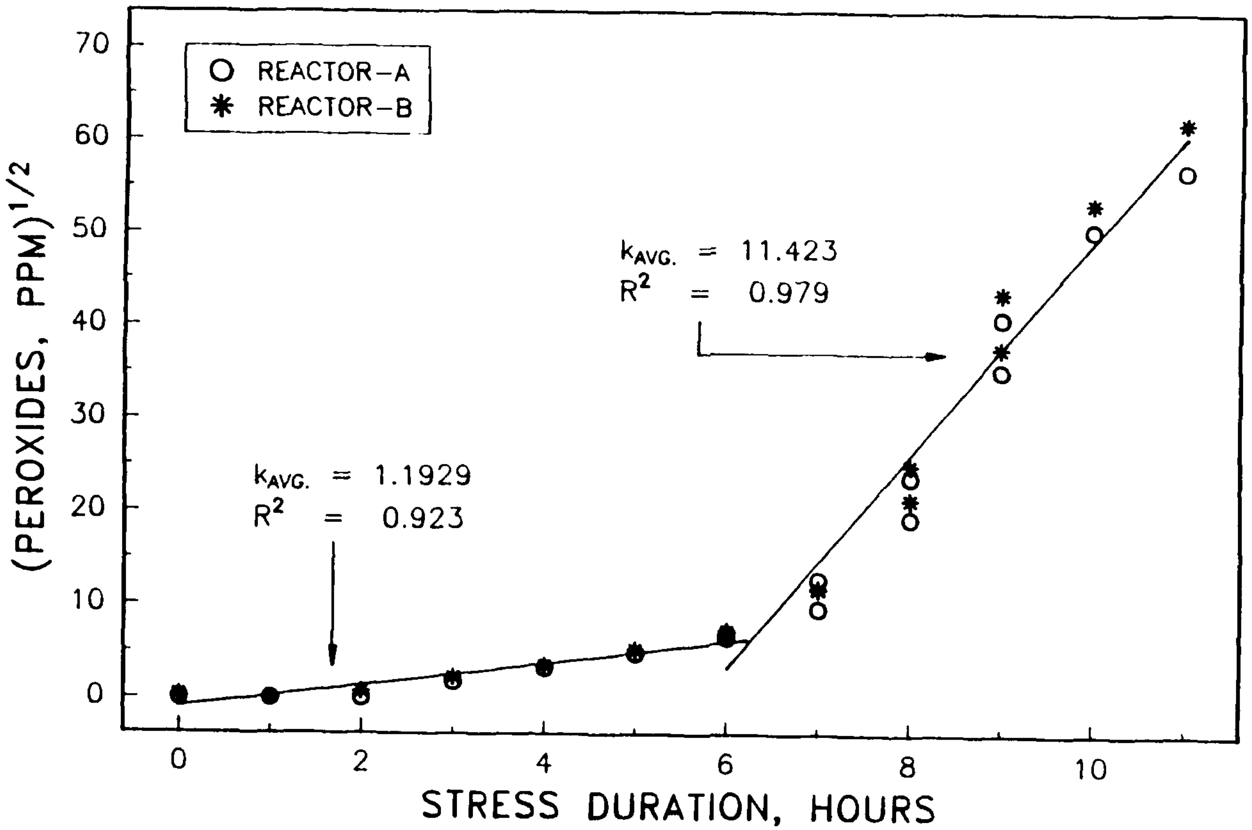
A01/PER30A.PLOT

Figure 50.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "A"



A01/PER32A.PLOT

Figure 51.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "B"



A01/PER34A.GRF

Figure 52.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "C"

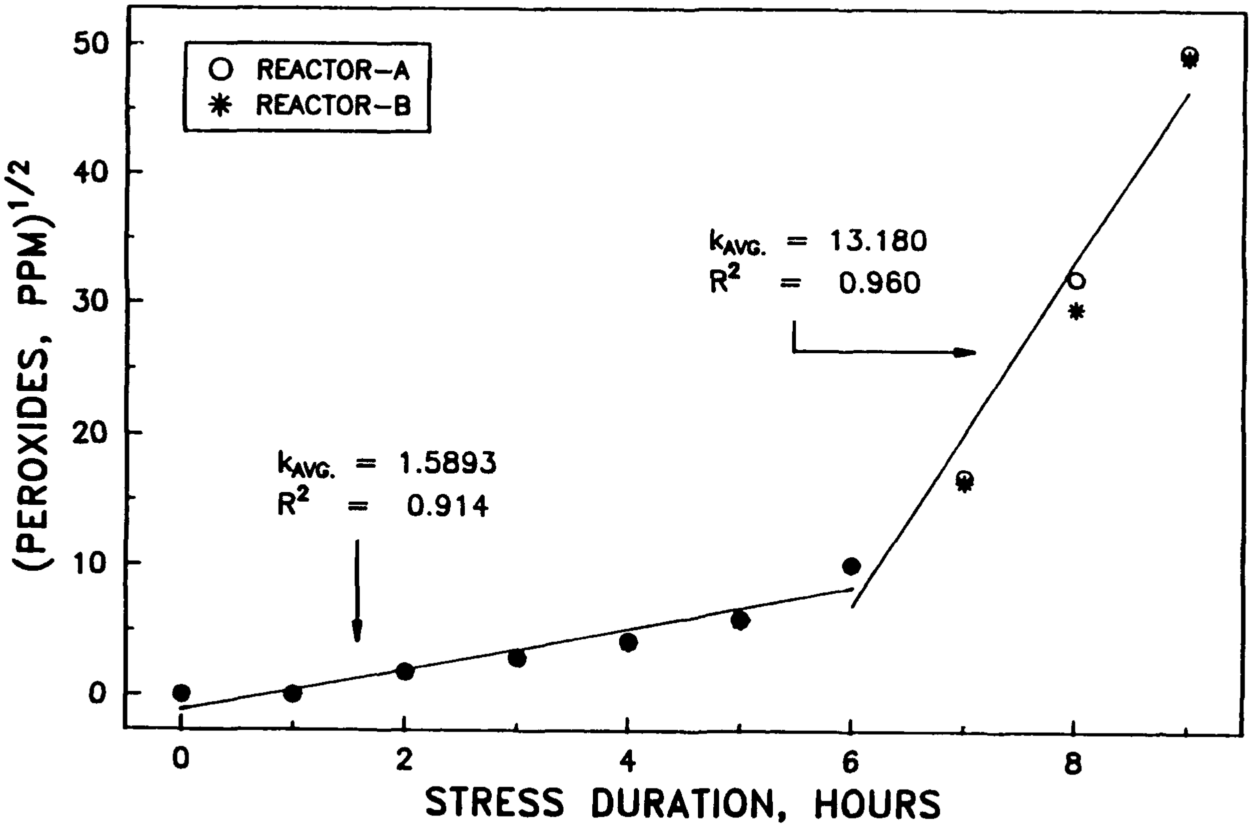
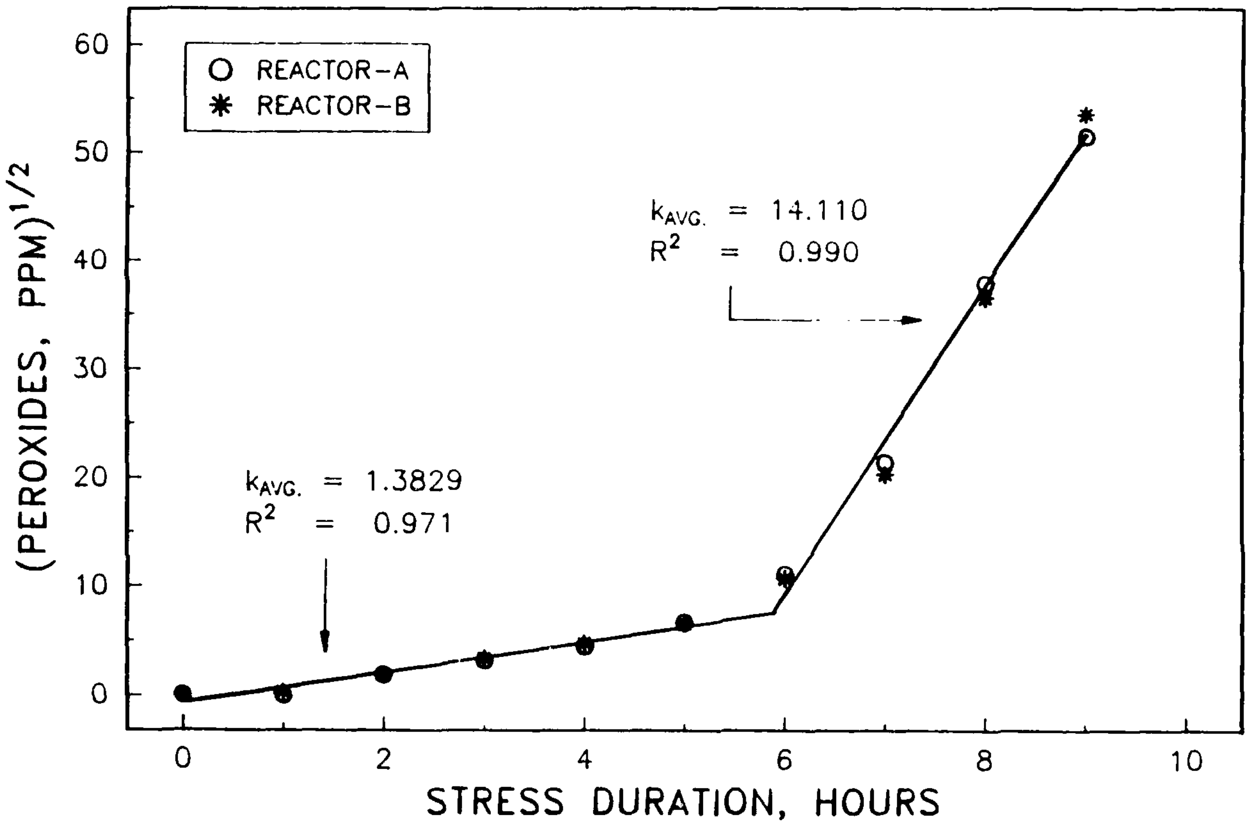
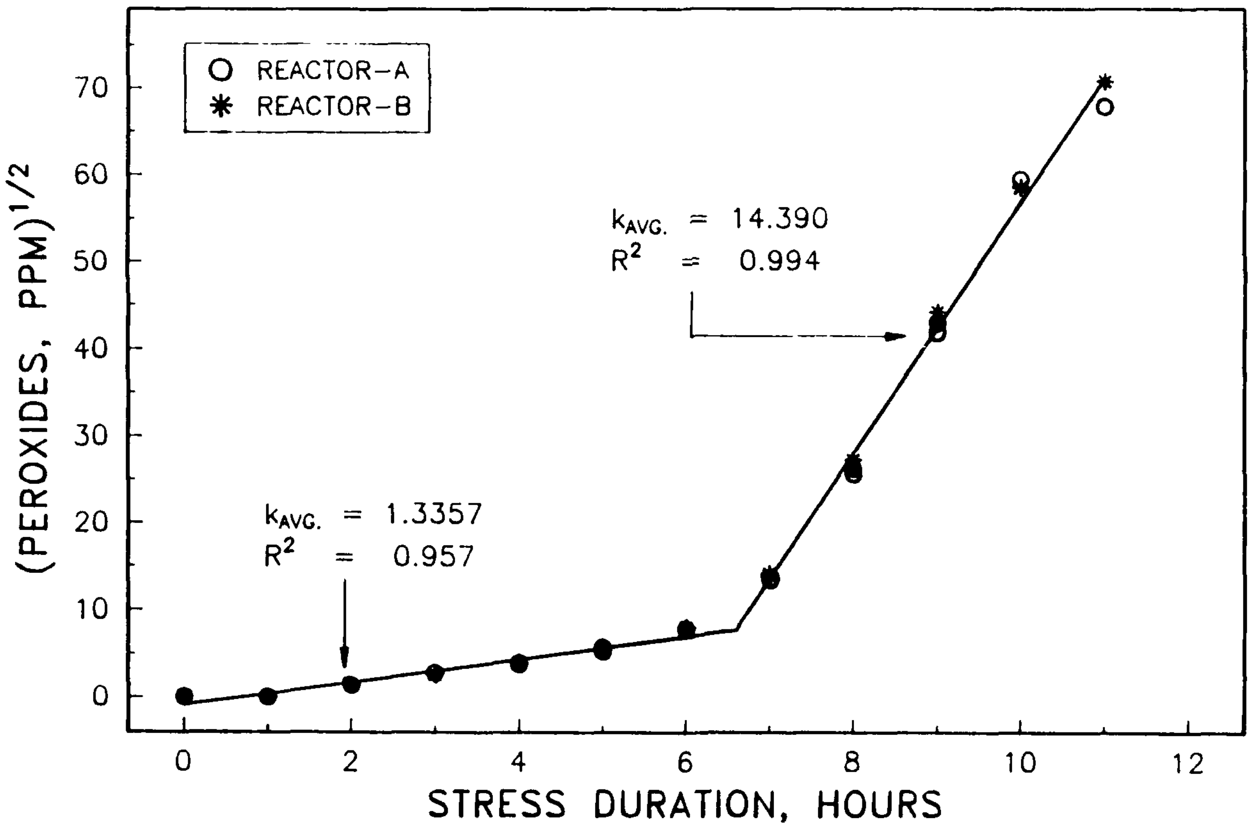


Figure 53.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "D"



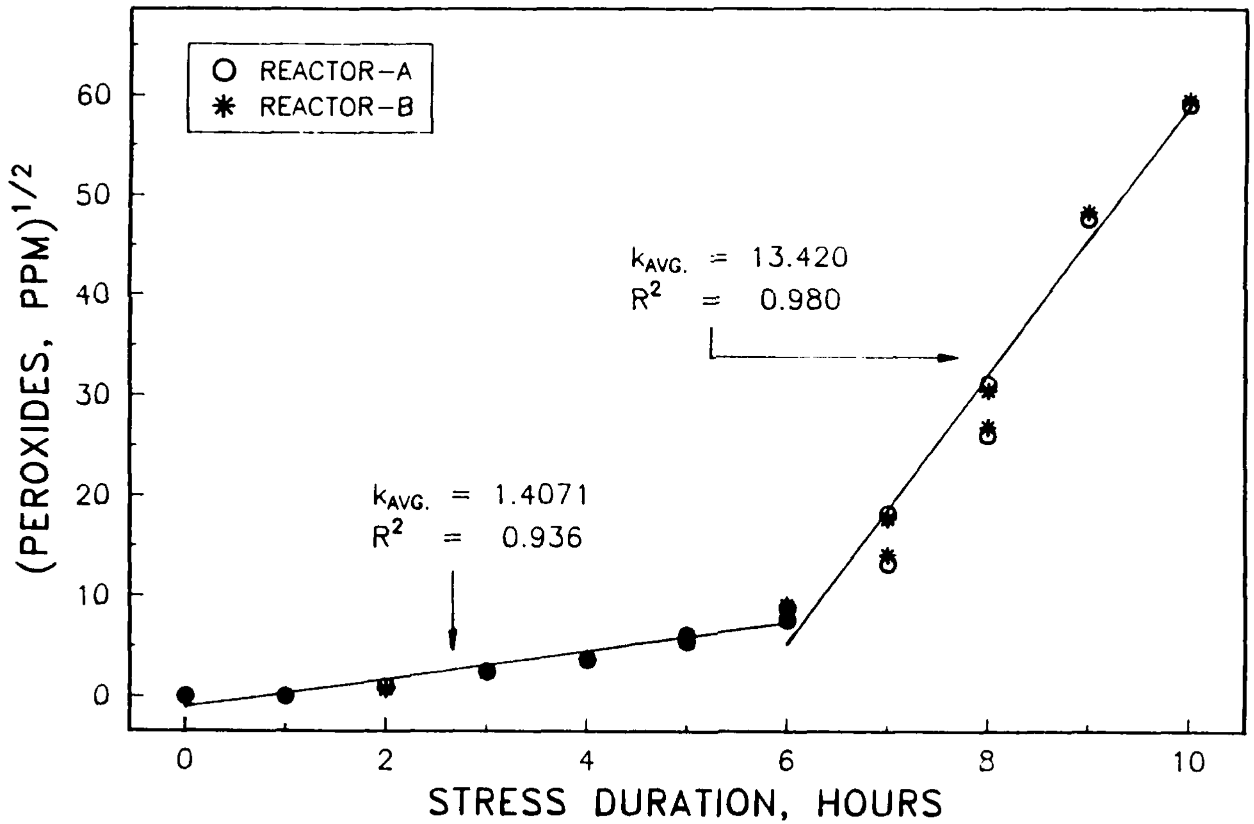
A01\PER38A.GRF

Figure 54.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "E"



A01\PER40A.GRF

Figure 55.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "F"



A01 PER42A.GRF

Figure 56.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "G"

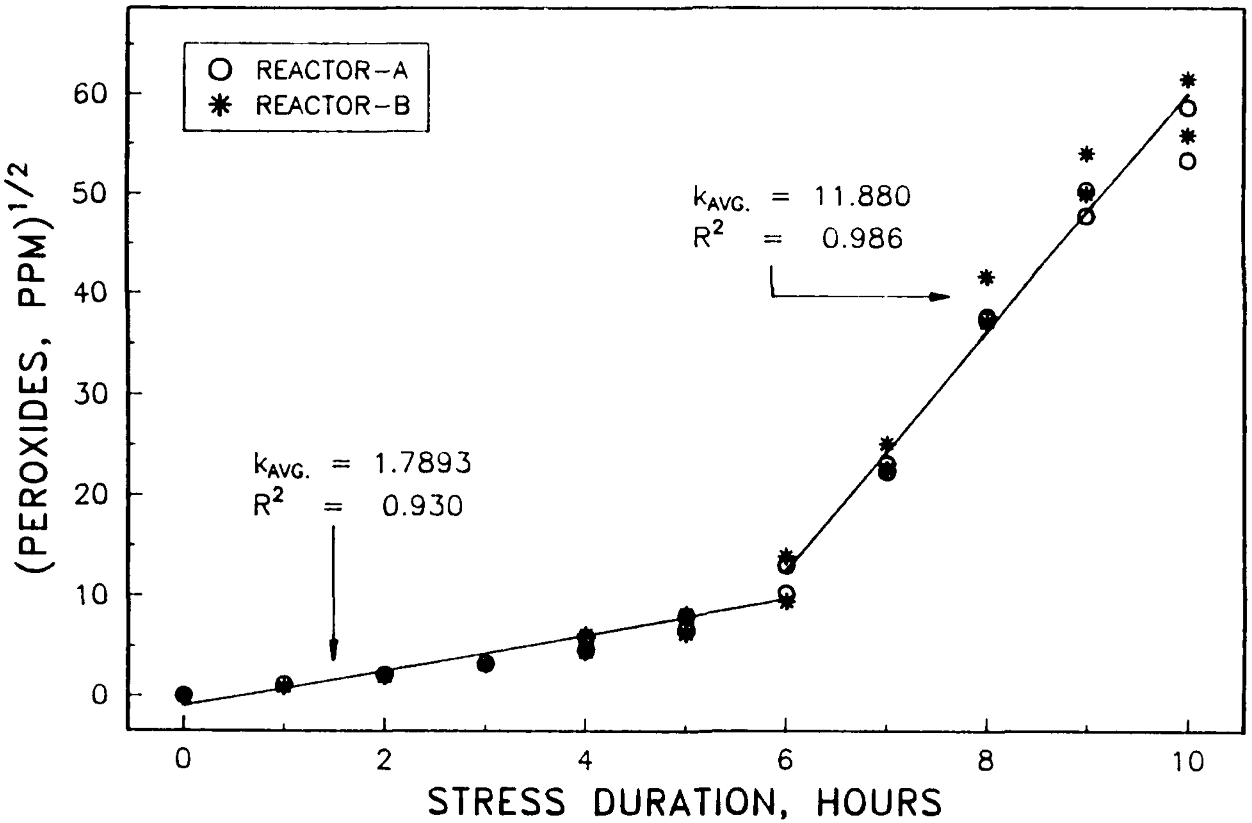
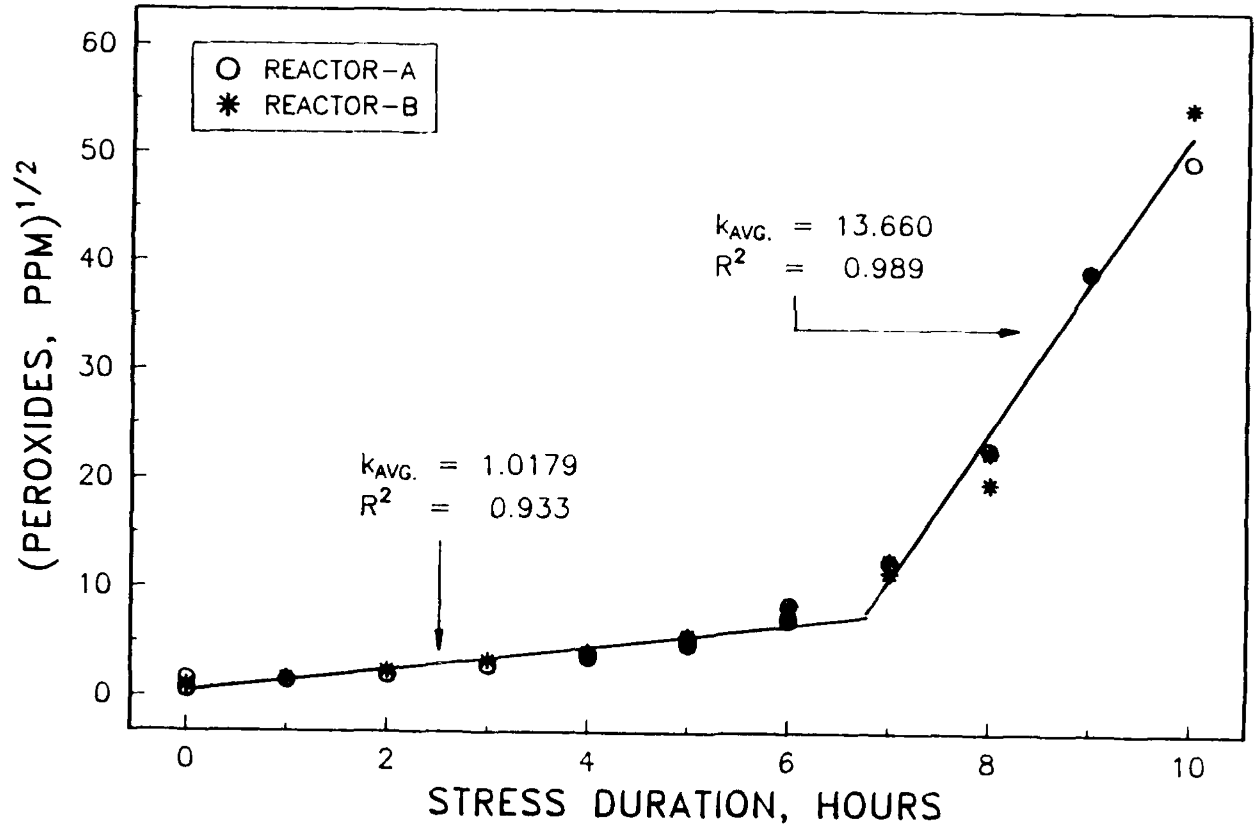
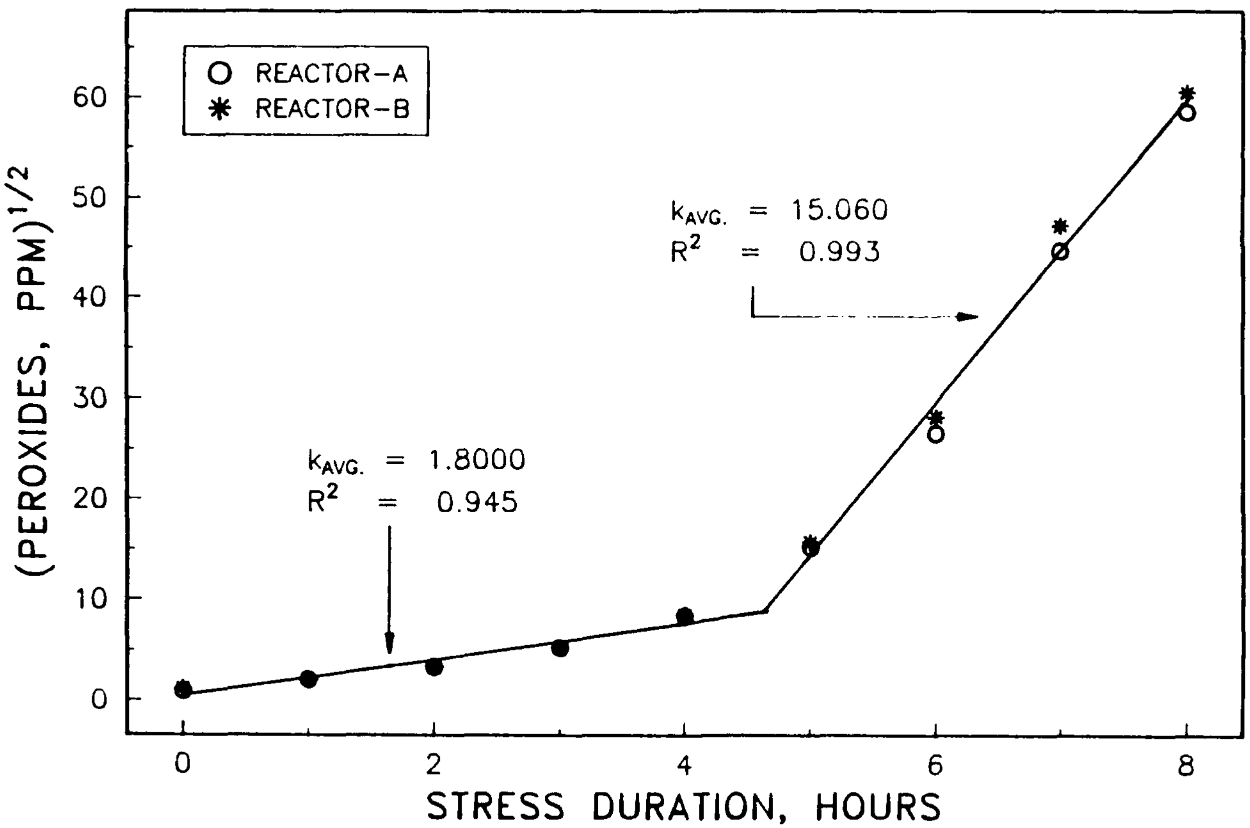


Figure 57.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "H"



A01 PER46A.GRF

Figure 58.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "I"



A01\PER48A.GRF

Figure 59.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "J"

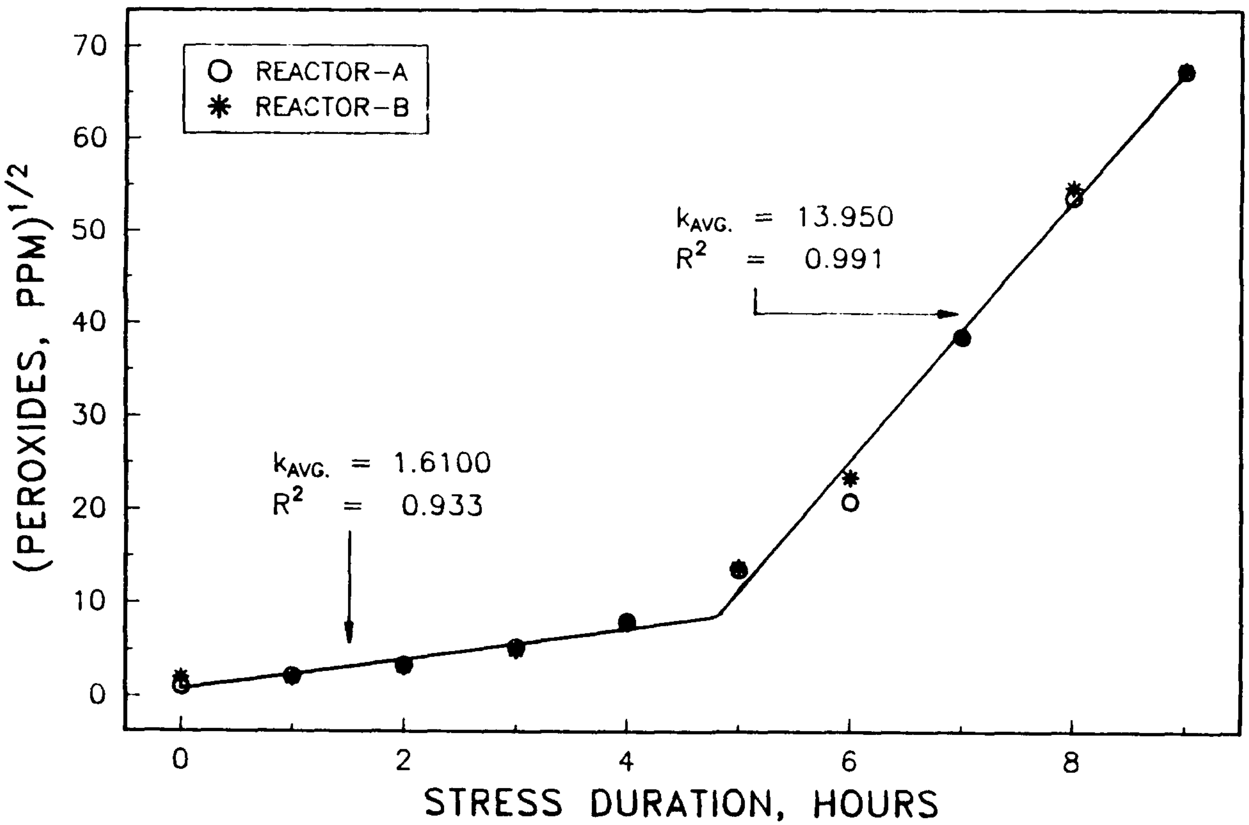
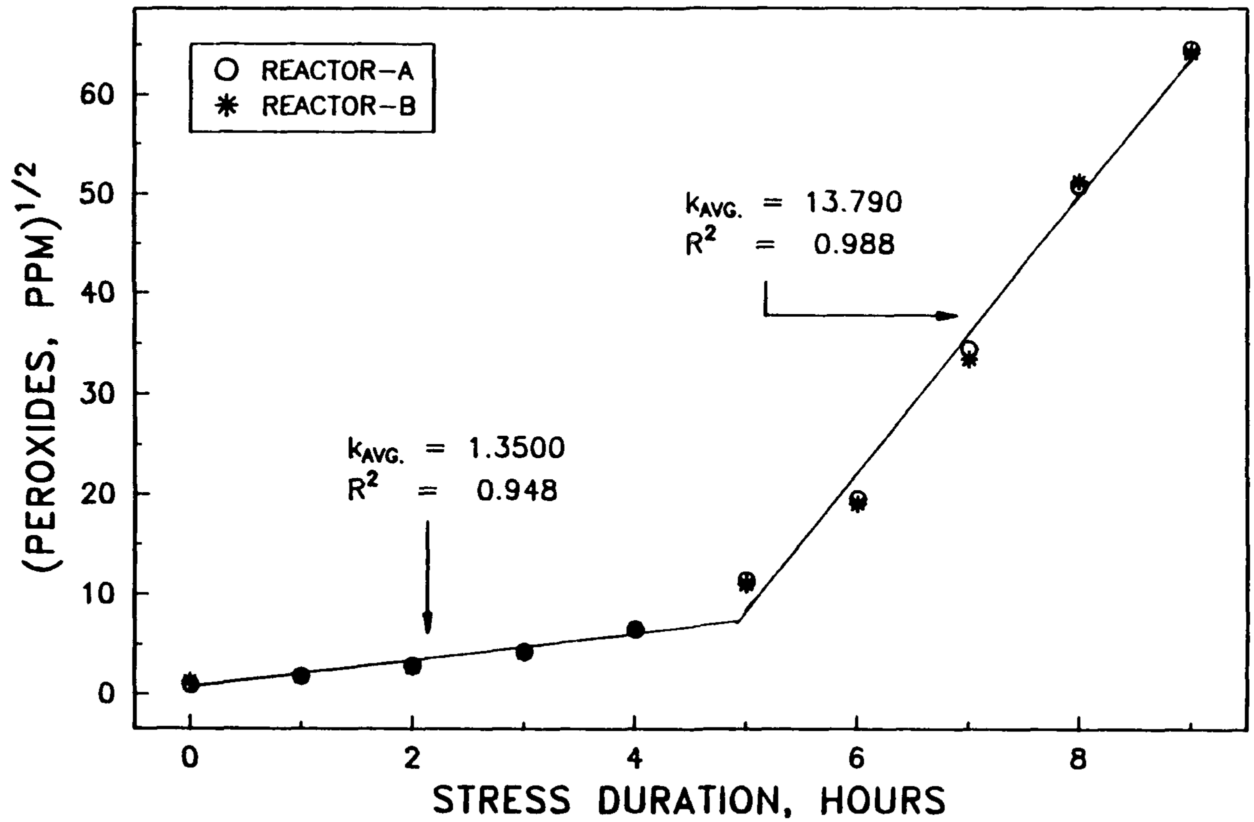


Figure 60.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "L"



A01\PER52A.GRF

Figure 61.
OXIDATION AT 120 °C OF FUEL 18496
CONTAINING 17 MG/L OF ADDITIVE "M"

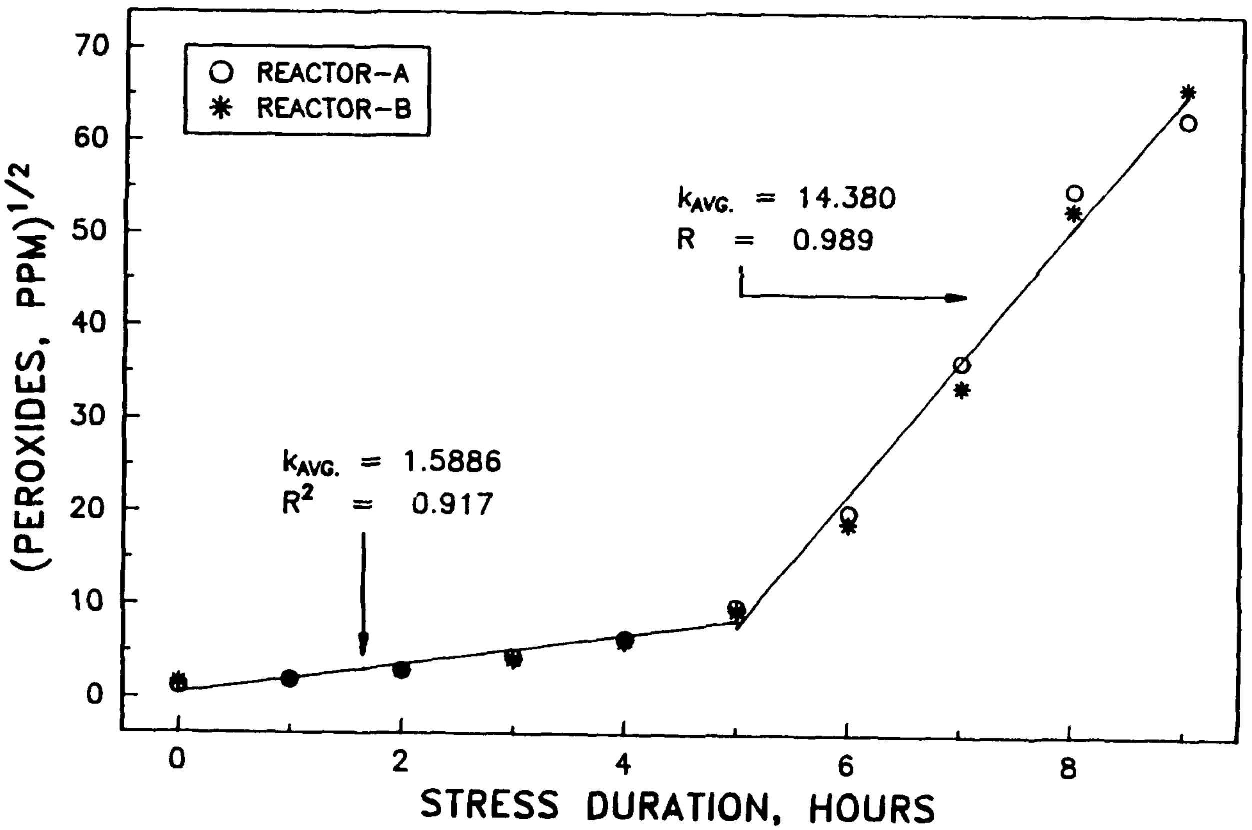


Figure 62.
OXIDATION AT 120 °C OF FUEL 18496 CONTAINING 17 MG/L OF ADDITIVE "N"

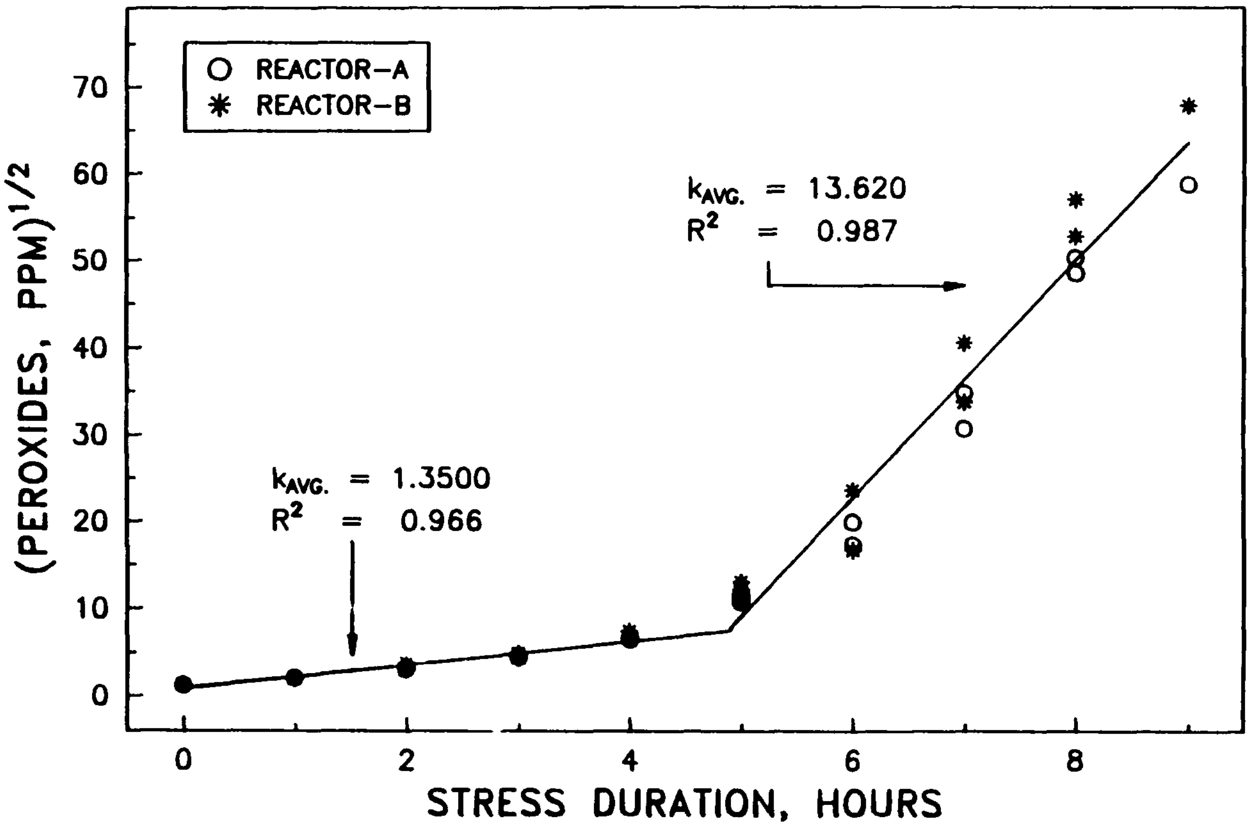


Figure 63.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "A"

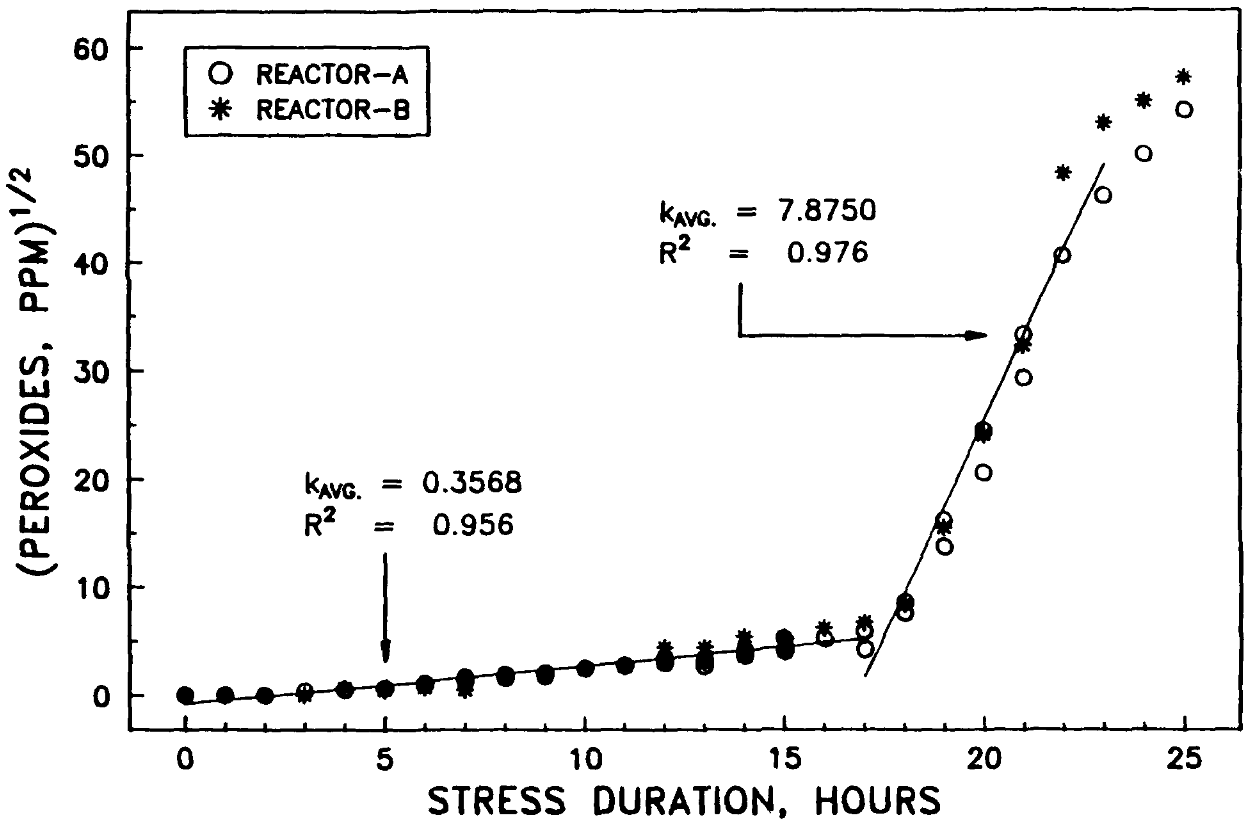
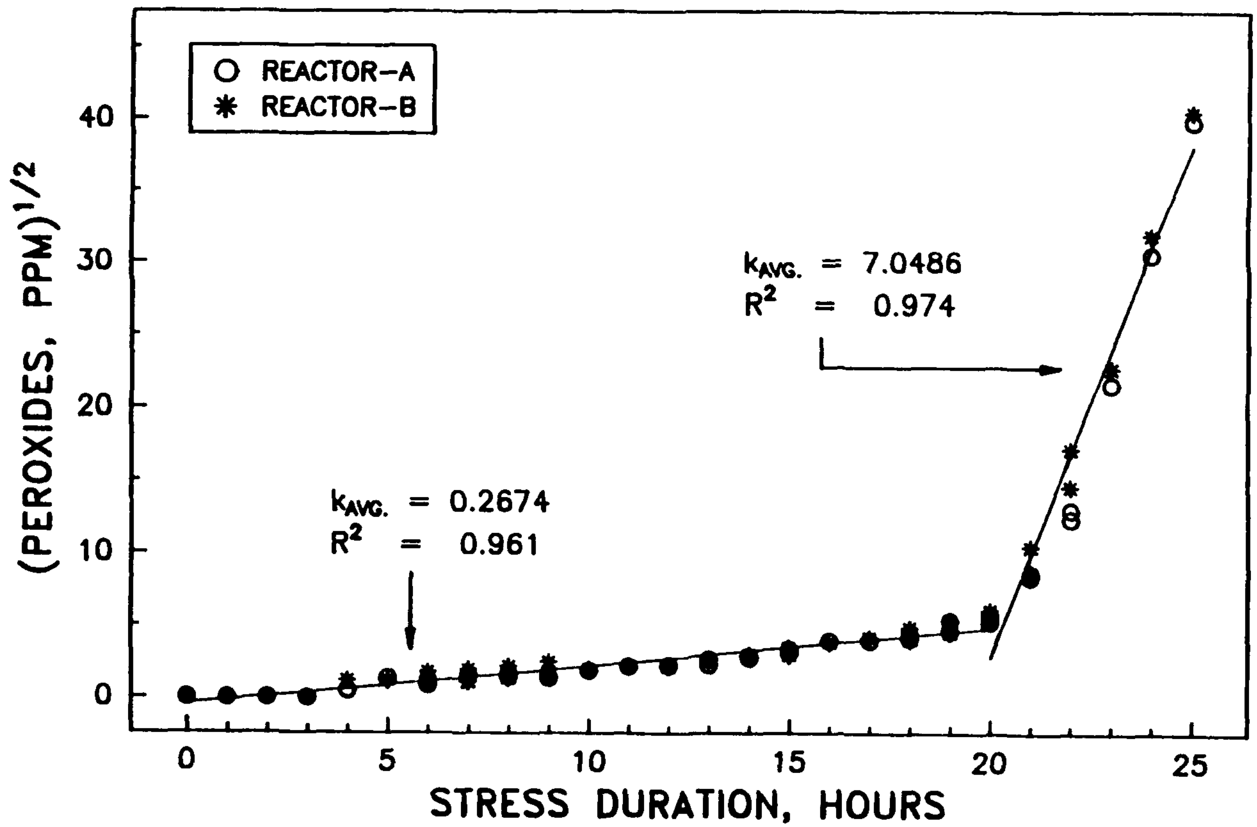


Figure 64.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "B"



A01\PER35A.GRF

Figure 65.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "C"

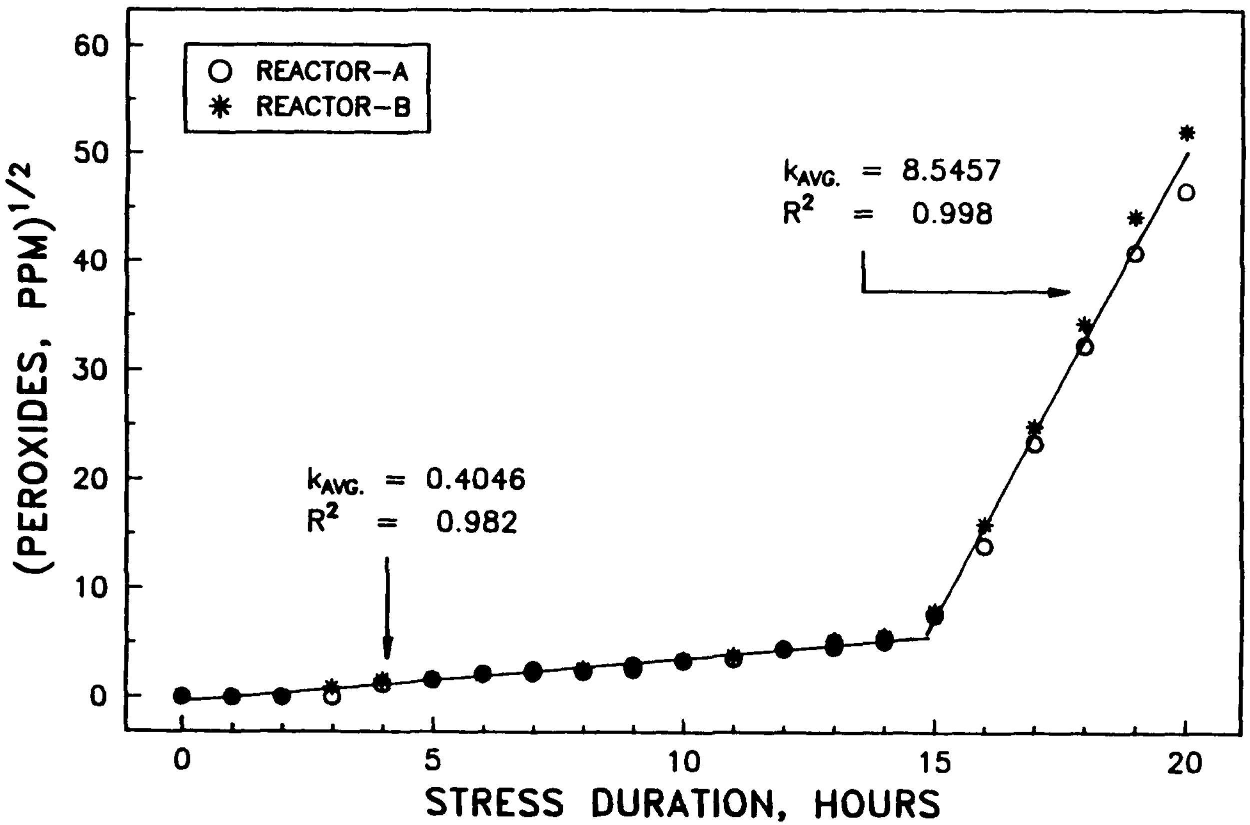
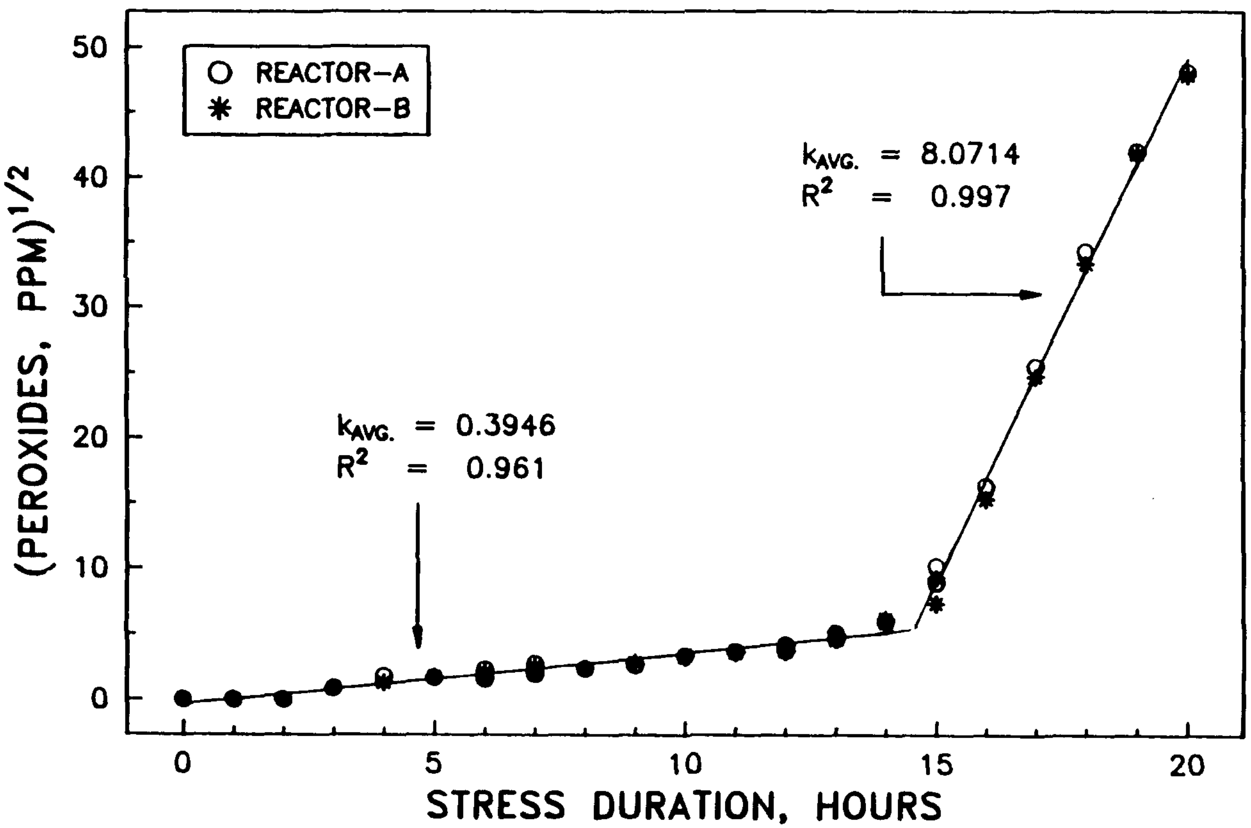
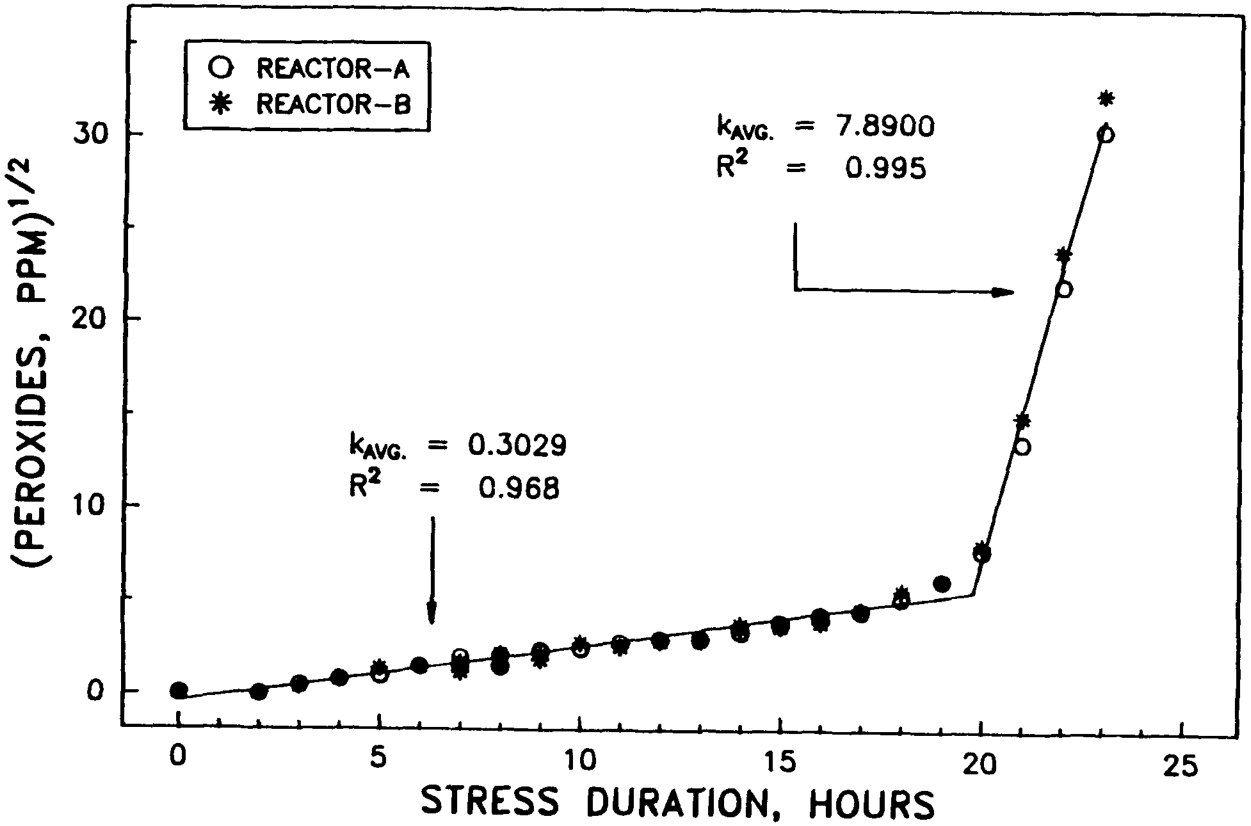


Figure 66.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "D"



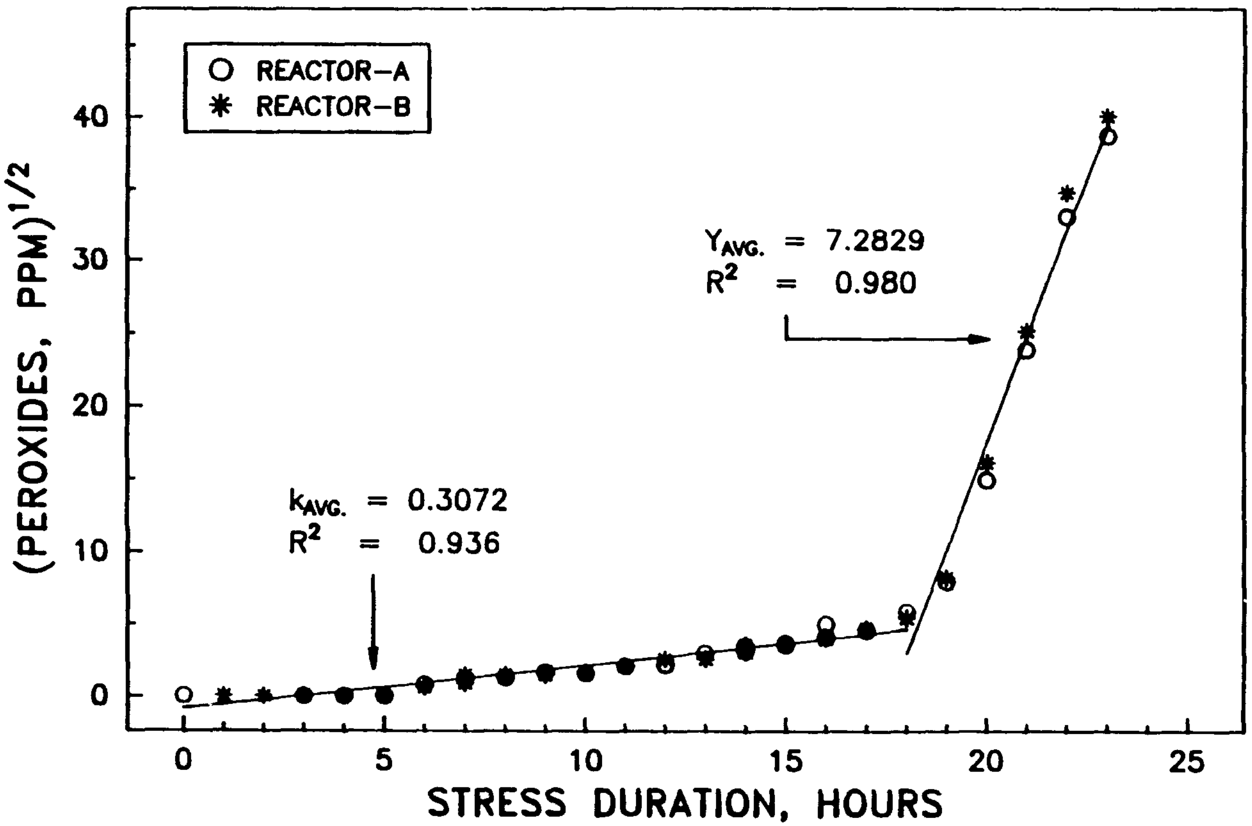
A01\PER39A.GRF

Figure 67.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "E"



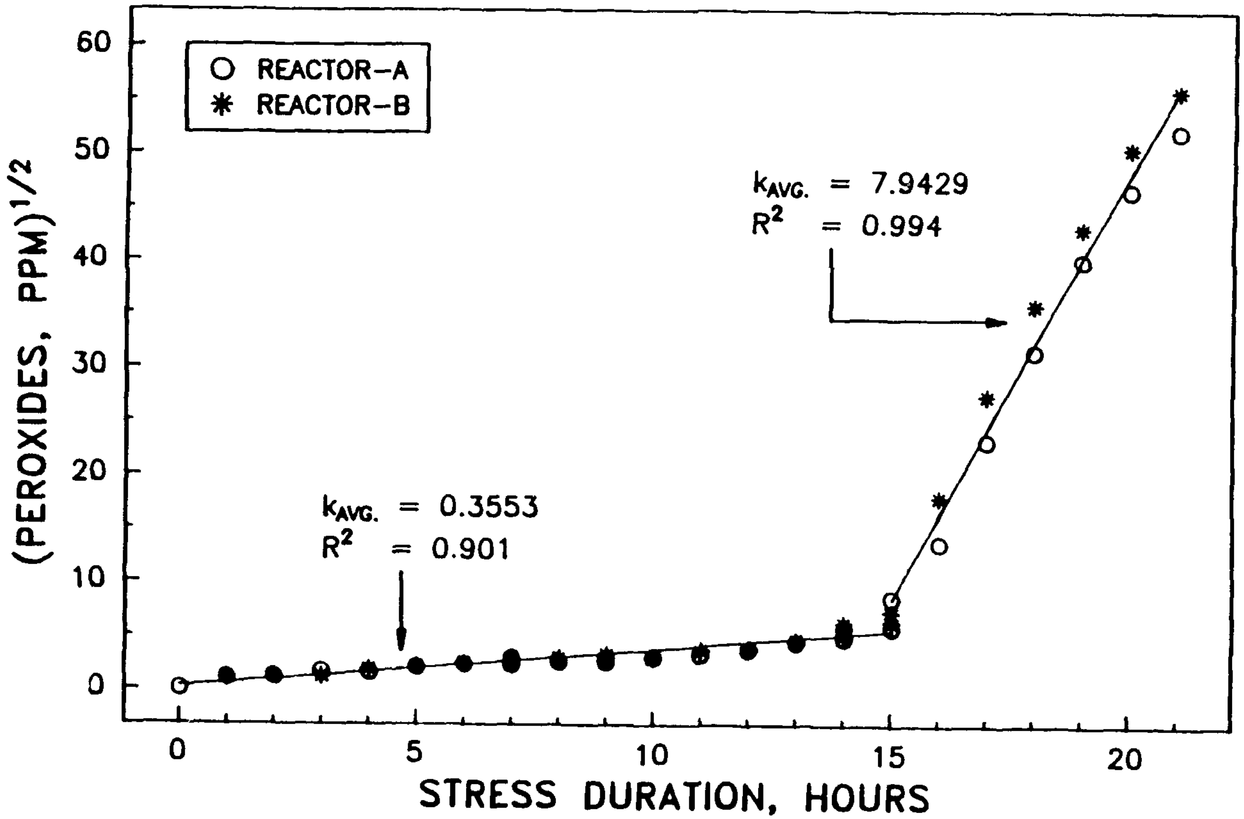
A01\PER41A.GRF

Figure 68.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "F"



A01\PER43A.GRF

Figure 69.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "G"



A01\PER45A.GRF

Figure 70.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "H"

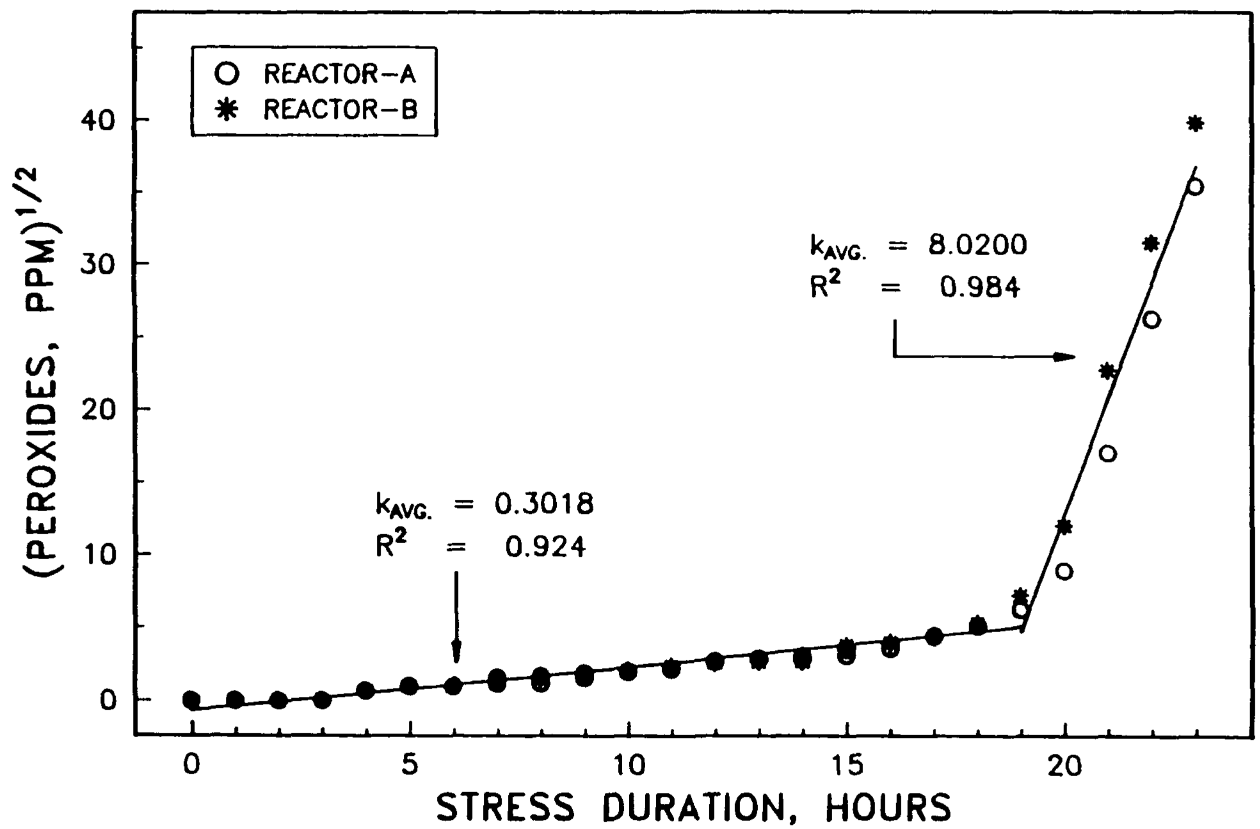
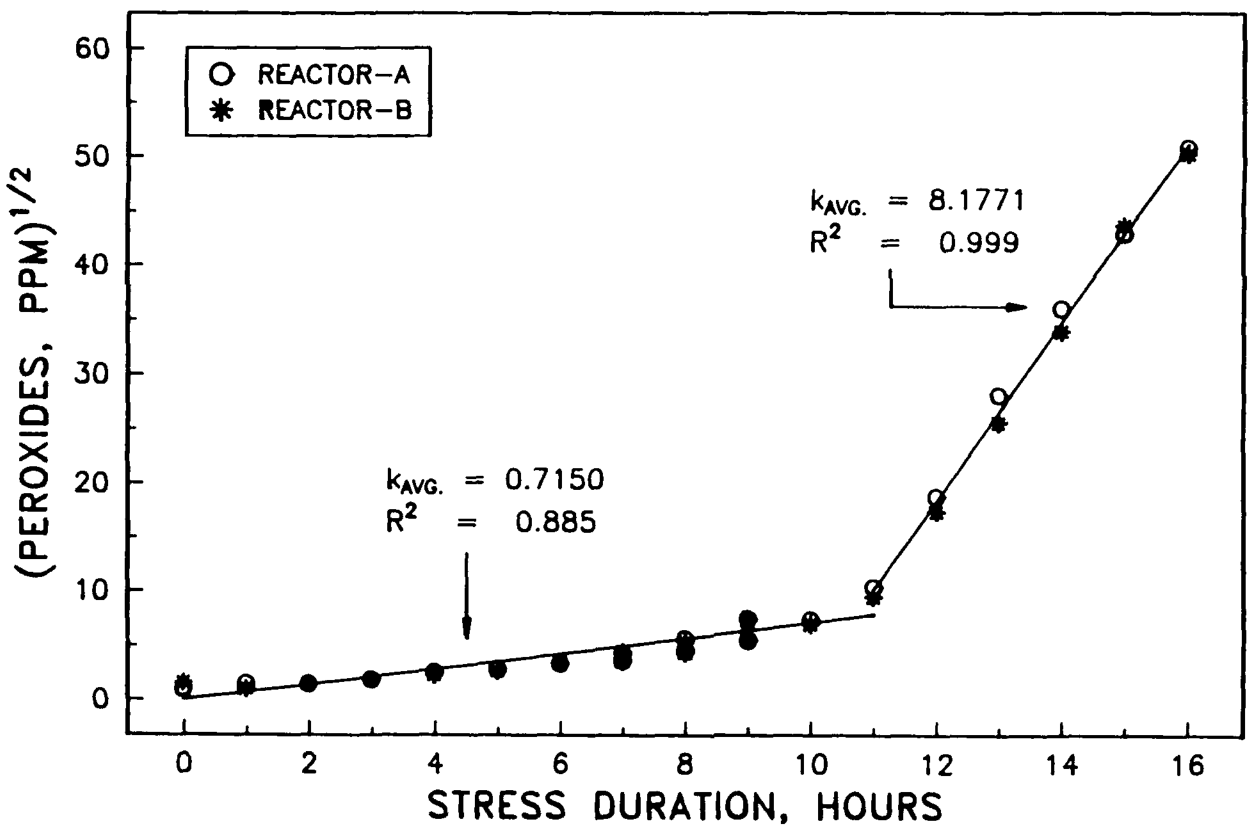
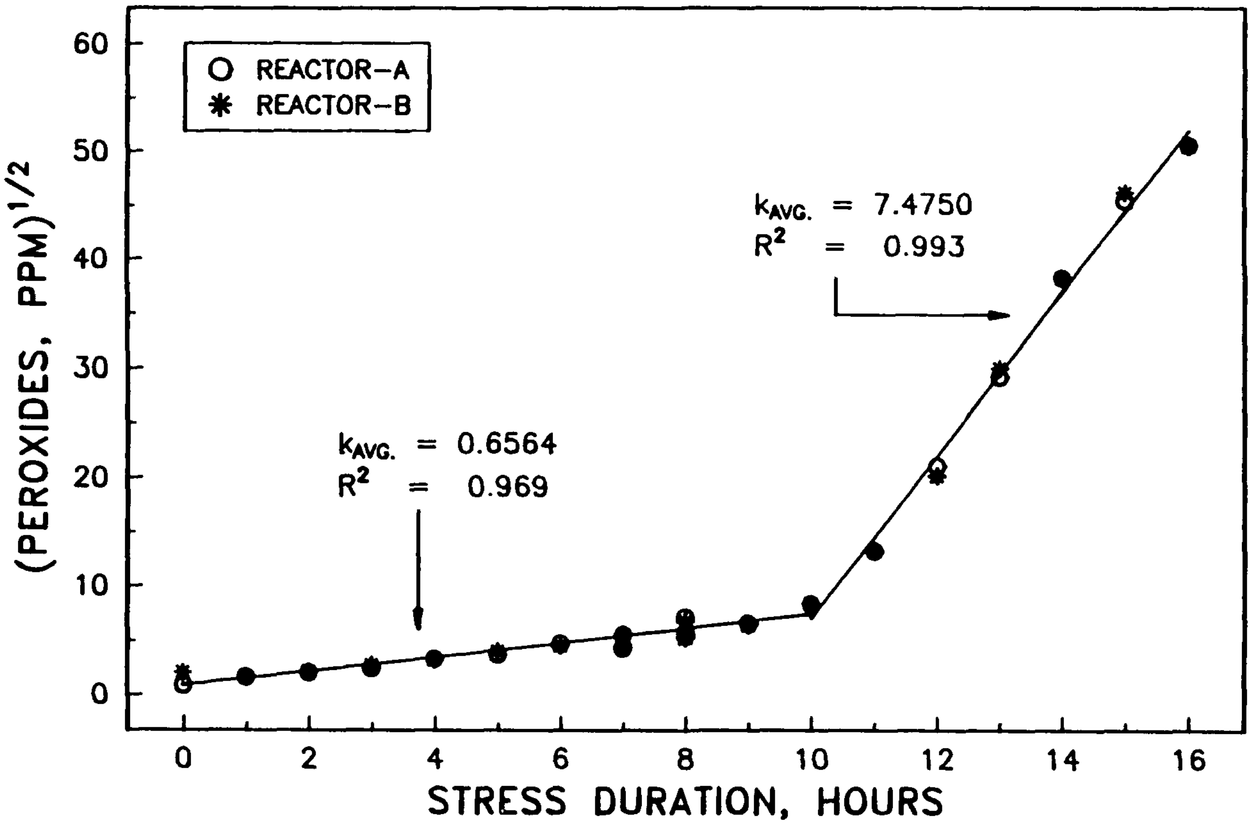


Figure 71.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "I"



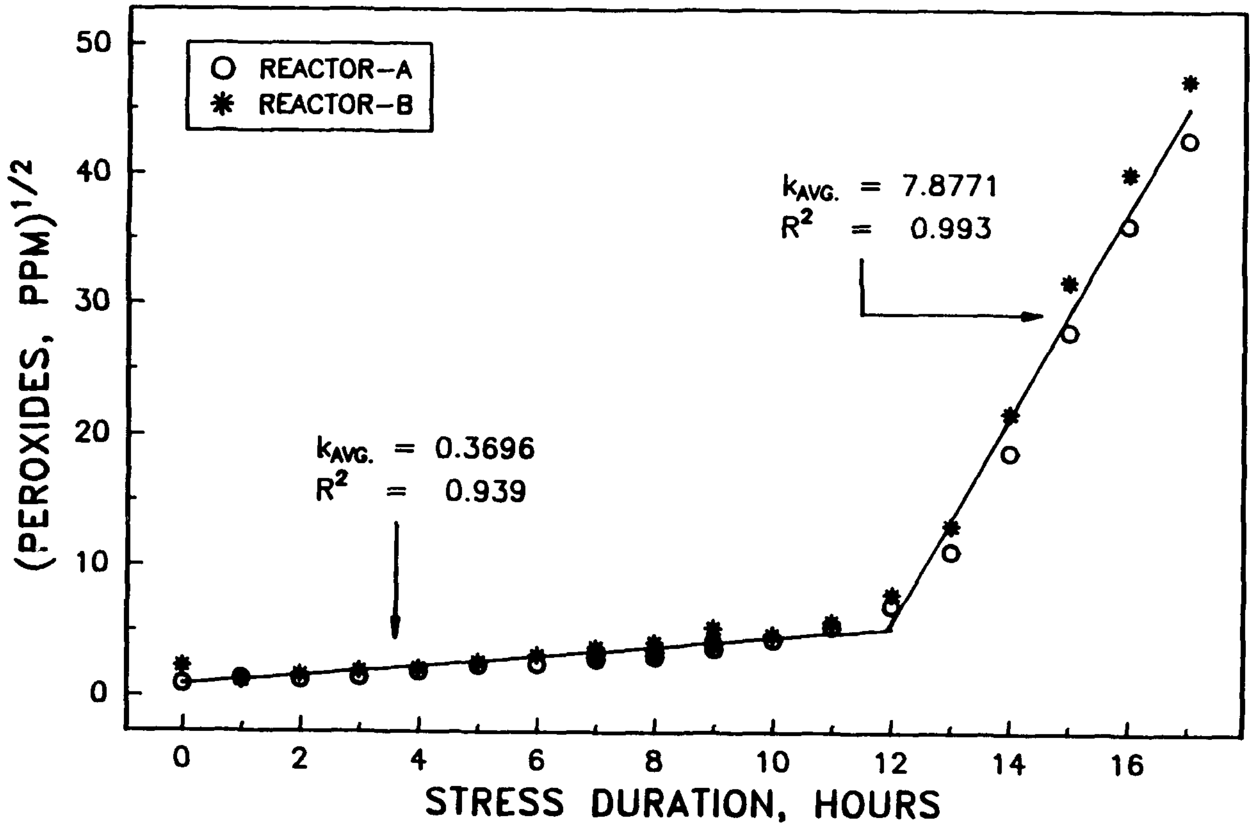
A01\PER49A.GRF

Figure 72.
OXIDATION AT 120 °C OF FUEL 18497
CONTAINING 17 MG/L OF ADDITIVE "J"



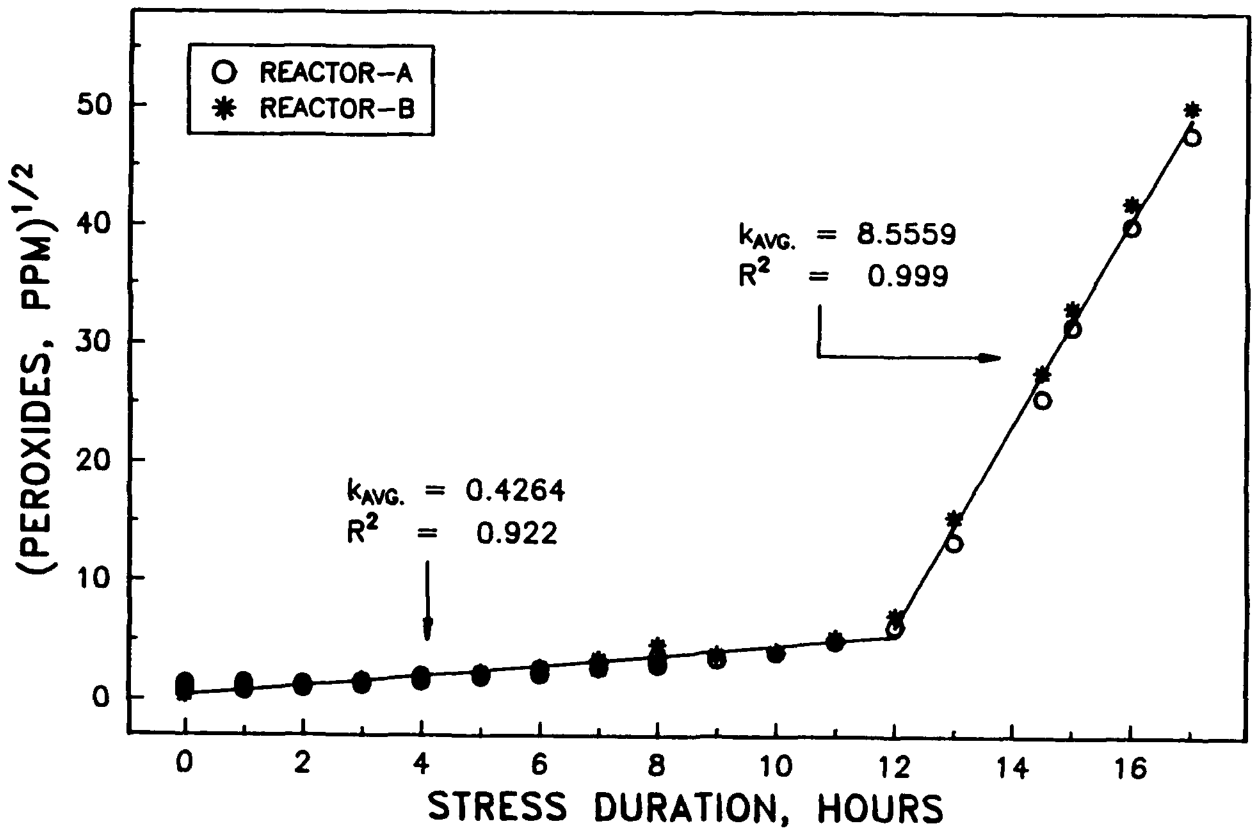
A01\PER51A.GRF

Figure 73.
OXIDATION AT 120 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "L"



A01\PER53A.GRF

Figure 74.
OXIDATION AT 120 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "M"



A01\PER55A.GRF

Figure 75.
OXIDATION AT 120 °C OF FUEL 18497 CONTAINING 17 MG/L OF ADDITIVE "N"

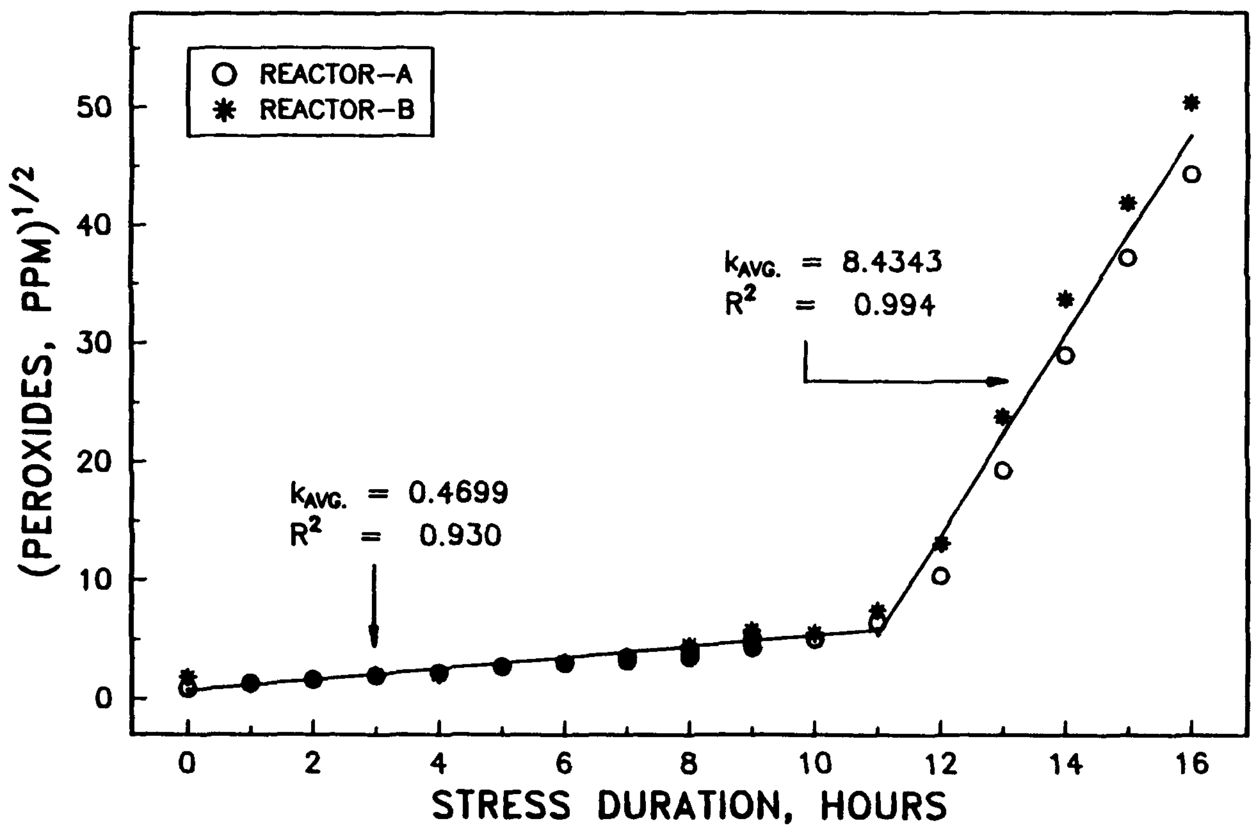


Figure 76. EVALUATION OF ANTIOXIDANTS AT 100 C

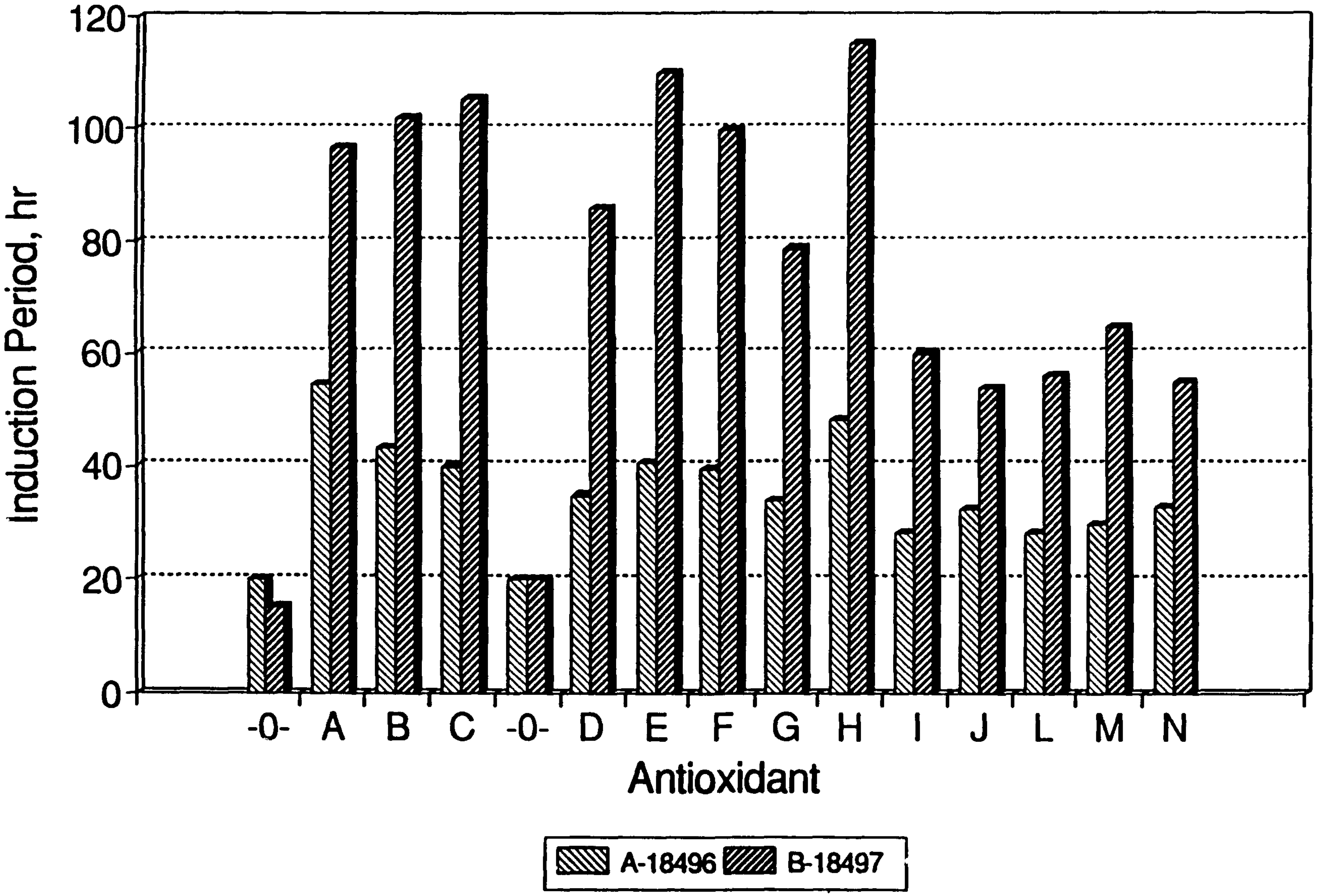


Figure 77. RELATIVE EFFICIENCIES OF ANTIOXIDANTS AT 100 C

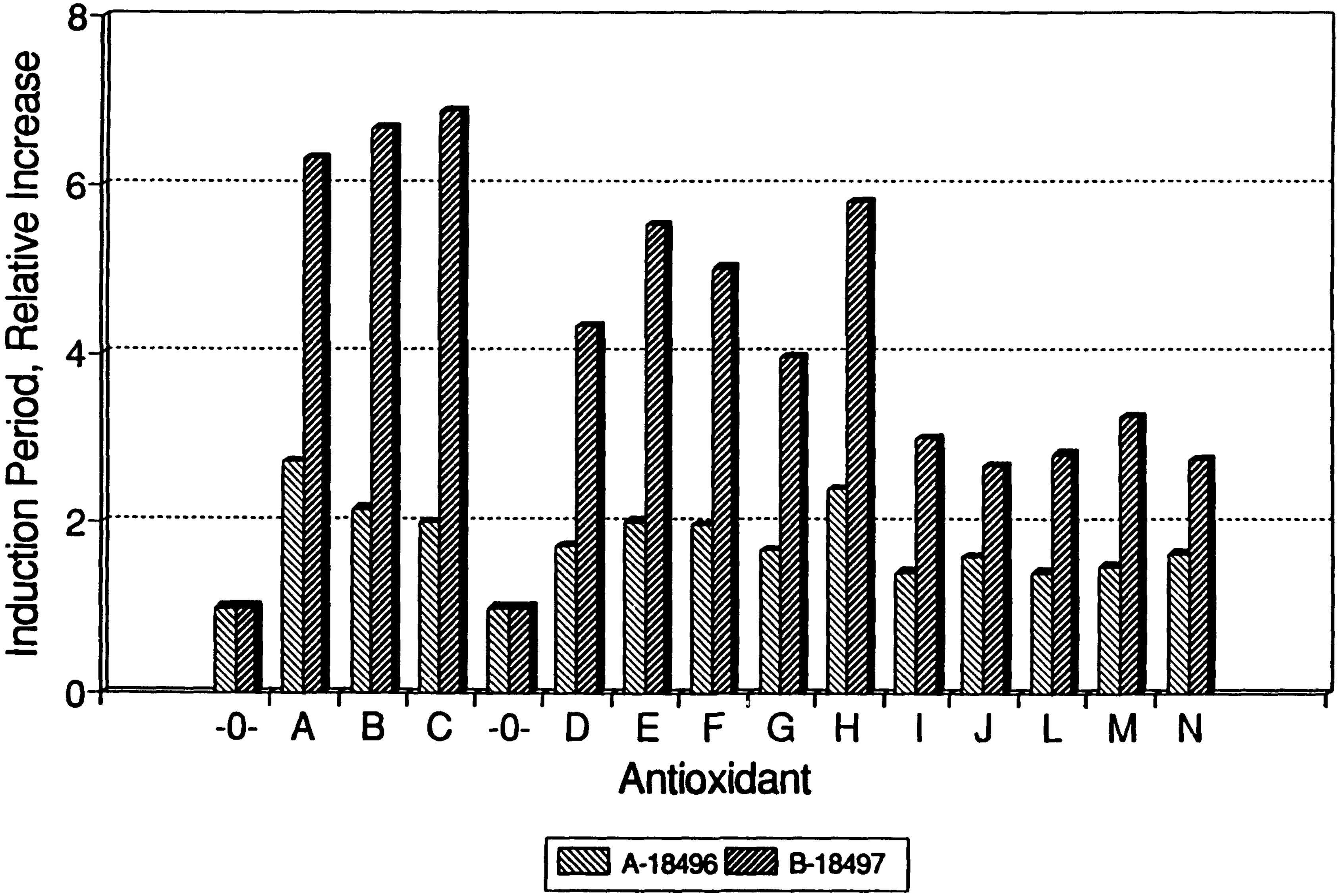


Figure 78. EVALUATION OF ANTIOXIDANTS AT 120 C

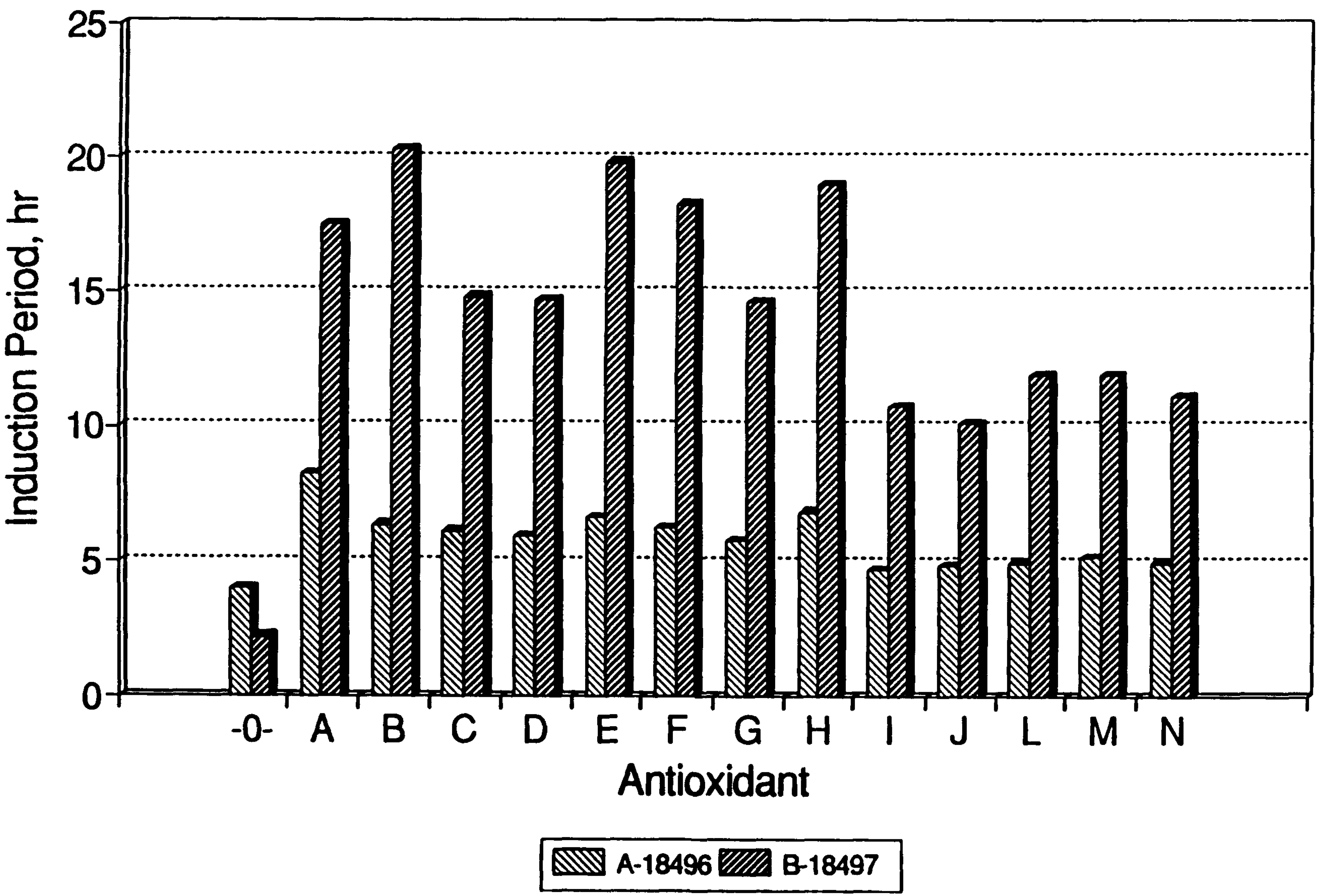
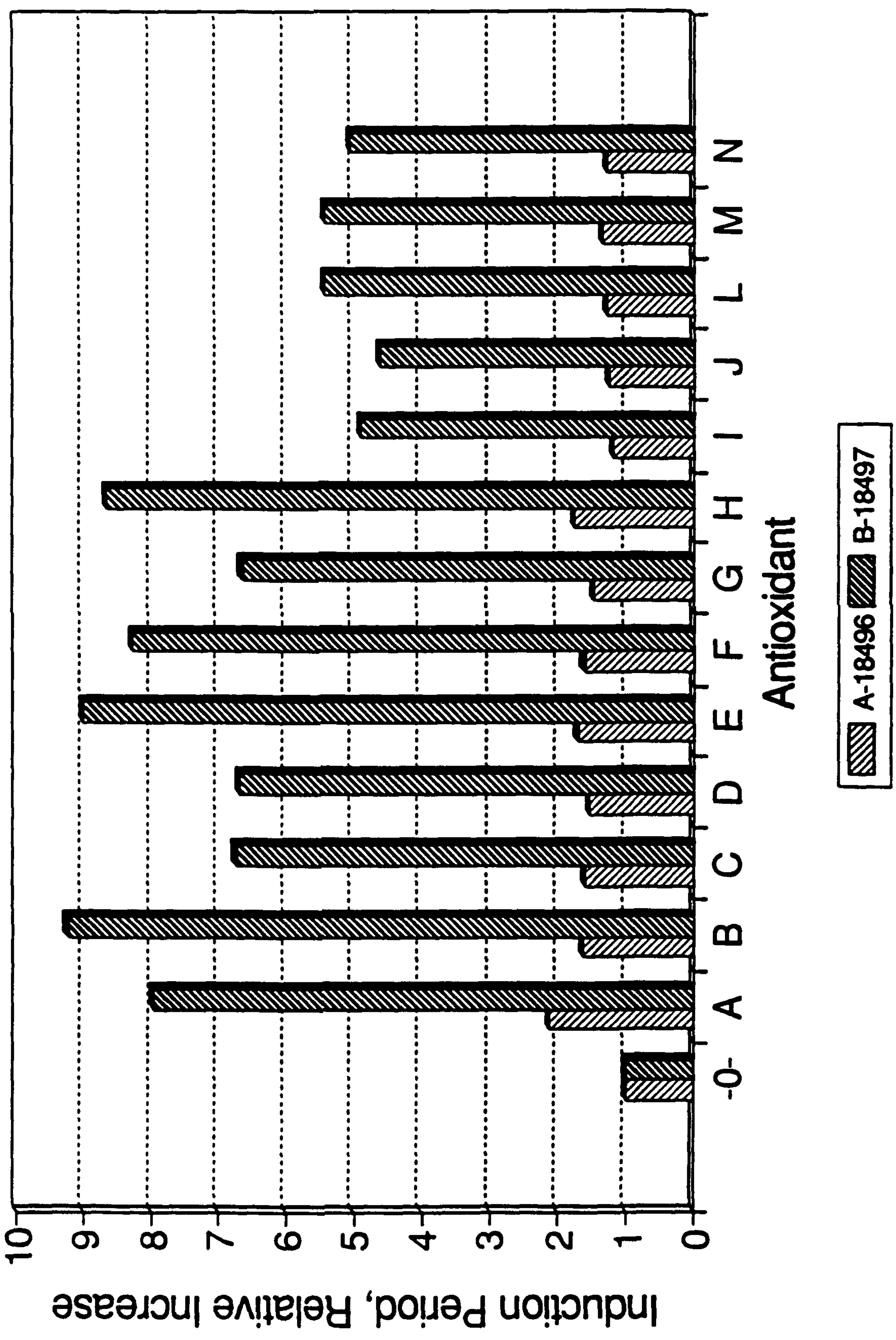


Figure 79. RELATIVE EFFICIENCIES OF ANTIOXIDANTS AT 120 C



TABLES

TABLE 1. Model Fuels

Fuel No.	Description
0464	Straight-run, additive-free, salt-dried, clay-treated kerosene
11310	Hydrocracked kerosene
11310A	Fuel 11310, alumina treated
11381	Hydrocracked kerosene
AV-284	Hydrofined kerosene
AV-284	Hydrocracked kerosene
15708	Hydroprocessed kerosene
16581	Hydroprocessed kerosene
18496	Hydrocracked kerosene
18497	Hydrocracked kerosene
-	Dodecane, distilled
-	Ethylbenzene, distilled
-	Tetralin, distilled and alumina treated

TABLE 2. Experimental Matrix

	Oxygen Pressure, kPa, at Stress Temperature, °C					
Fuel No.	43[a]	60	65[a]	80	100	120
0464	21	790	-	790 & 1140	240 & 790	240
11310	21	790	-	790 & 1140	240 & 790	240
11310A	21	790	-	790 & 1140	240 & 790	240
11381	21	790	-	790 & 1140	240 & 790	240
AV-284	-	-	21	790 & 1140	240 & 790	240
AV-285	-	-	21	790 & 1440	240 & 790	240
15708	21	-	-	240	240	240
16581	21	-	-	240	240	240
18496	-	-	-	240	240	240
18497	-	-	-	240	240	240

[a] Bottle storage tests using air; all other tests under oxygen pressure between 240 and 1140 kPa.

TABLE 3. Global Mechanism of Autoxidation

Initiation	$ROOH$	$= RO\bullet + OH\bullet$	(k_i)	(1)
Radical exchange	$RO\bullet + RH$	$= ROH + R\bullet$		(2)
	$OH\bullet + RH$	$= HOH + R\bullet$		(3)
Chain propagation	$R\bullet + O_2$	$= RO_2\bullet$	(k_{1p})	(4)
	$RO_2\bullet + RH$	$= ROOH + R\bullet$	(k_{2p})	(5)
Chain breaking	$RO_2\bullet + AH$	$= ROOH + A\bullet$	(k_{cb})	(6)
	$RO_2\bullet + A\bullet$	= Products		(7)
	$RO_2\bullet + NI$	= Products		(8)
Radical termination	$RO_2\bullet + RO_2\bullet$	= Products	(k_t)	(9)
	$R\bullet + R\bullet$	= Products	(k_{t1})	(10)

TABLE 4. Peroxide Formation During Oxidation of Fuel Nos. 15708 and 16581 at 43°C

Stress Duration		(Peroxides, ppm)$^{1/2}$	
Weeks	Hours	15708	16581
0	0	0.0	0.0
4	672	0.4	1.3
6	1008	1.7	2.4
8	1344	1.8	1.4
10	1680	3.4	2.1
14	2352	3.3	2.7
18	3024	7.4	3.3
22	3696	19.6	3.9
26	4368	23.4	5.7
30	5040	28.4	7.4
34	5712	32.0	6.7
38	6384	35.3	18.6
42	7056	38.0	24.4
46	7728	40.7	28.1
50	8400	42.6	31.4

Linear Regression Analysis of the Data

Fuel No. 15708:

Induction Period (0-14 weeks):

Y = 0.001624*X - 0.1435
ln k = -6.4227
R^2 = 0.878

Post-Induction Period: (14-50 weeks):
Y = 0.001206*X + 0.1863
ln k = -6.7204
R^2 = 0.933

Fuel No. 16581:

Induction Period (0-34 weeks):

Y = 0.006476*X - 7.7470
ln k = -5.0396
R^2 = 0.941

Post-Induction Period (34-50 weeks):

Y = 0.008765*X - 40.05
ln k = -4.7370
R^2 = 0.921

TABLE 5. Oxidation of Fuel No. 15708 at 80°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.0	0.19	19.0
0	0.9	-	0.9	-	-	-
0	1.0	-	1.0	-	-	-
0	-	1.3	1.3	-	-	-
5	1.3	-	1.3	1.4	0.38	27.1
5	1.0	-	1.5	-	-	-
5	-	1.5	1.0	-	-	-
5	-	1.9	1.9	-	-	-
10	-	2.2	2.2	1.9	0.42	22.1
10	-	1.6	1.6	-	-	-
15	2.2	-	2.2	2.4	0.15	6.3
15	-	2.5	2.5	-	-	-
15	-	2.4	2.4	-	-	-
20	4.1	-	4.1	3.2	0.74	23.1
20	2.3	-	2.3	-	-	-
20	-	3.2	3.2	-	-	-
20	-	3.1	3.1	-	-	-
25	4.8	-	4.8	3.8	0.95	25.0
25	2.9	-	2.9	-	-	-
25	-	3.8	3.8	-	-	-
30	3.9	-	3.9	4.4	0.64	14.5
30	-	4.8	4.8	-	-	-
35	-	7.3	7.3	7.0	0.35	5.0
35	-	6.8	6.8	-	-	-
40	6.9	-	6.9	9.0	2.10	23.0
40	-	9.1	9.1	-	-	-
40	-	11.1	11.1	-	-	-
45	8.4	-	8.4	11.7	3.69	31.5
45	11.1	-	11.1	-	-	-
45	-	15.7	15.7	-	-	-
50	12.5	-	12.5	11.2	1.77	15.8
50	10.0	-	10.0	-	-	-
55	14.2	-	14.2	15.7	2.12	13.5
55	-	17.2	17.2	-	-	-
60	-	21.9	21.9	23.4	2.05	8.8
60	-	24.8	24.8	-	-	-
65	-	28.7	28.7	28.7	-	-
70	30.0	-	30.0	27.9	2.97	10.6
70	25.8	-	25.8	-	-	-

TABLE 5. Oxidation of Fuel No. 15708 at 80°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-30 hours):		
Y = 0.11305*X +0.80986	0.810	Reactor-A
Y = 0.11265*X +0.98541	0.929	Reactor-B
Y = 0.11328*X +0.89158	0.850	Combined Data
Y = 0.11643*X +0.83929	0.992	Average Data
Post-Induction Period (30-70 hours):		
Y = 0.63713*X -18.566	0.921	Reactor-A
Y = 0.64984*X -15.478	0.961	Reactor-B
Y = 0.61860*X -15.732	0.890	Combined Data
Y = 0.63967*X -16.539	0.928	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 6. Oxidation of Fuel No. 15708 at 100°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	2.0	-	2.0	2.7	1.08	4.0
0	3.7	-	3.7	-	-	-
0	-	3.6	3.6	-	-	-
0	-	1.6	1.6	-	-	-
5	7.6	-	7.6	9.3	1.65	17.7
5	10.3	-	10.3	-	-	-
5	-	8.3	8.3	-	-	-
5	-	11.1	11.1	-	-	-
10	19.6	-	19.6	21.5	2.63	12.2
10	-	24.5	24.5	-	-	-
10	-	12.0	19.0	-	-	-
10	-	22.9	22.9	-	-	-
15	39.5	-	39.5	37.7	1.95	5.2
15	35.0	-	35.0	-	-	-
15	-	38.6	38.6	-	-	-
15	-	37.5	37.5	-	-	-
20	47.3	-	47.3	49.0	1.50	3.1
20	-	49.8	49.8	-	-	-
20	-	50.0	50.0	-	-	-
25	58.7	-	58.7	62.6	3.30	5.3
25	-	64.5	64.5	-	-	-
25	-	64.6	64.6	-	-	-

Linear Regression Analysis of the Data

Equation	R^2	Source
Y = 2.3388*X +0.1688	0.980	Reactor-A
Y = 2.5570*X -1.0096	0.986	Reactor-B
Y = 2.4745*X -0.5140	0.981	Combined Data
Y = 2.4846*X -0.5905	0.990	Average

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 7. Oxidation of Fuel No. 15708 at 120°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.7	-	1.7	3.0	1.00	33.3
0	4.0	-	4.0	-	-	-
0	2.2	-	2.2	-	-	-
0	3.2	-	3.2	-	-	-
0	-	1.8	1.8	-	-	-
0	-	4.0	4.0	-	-	-
0	-	3.2	3.2	-	-	-
0	-	4.1	4.1	-	-	-
1	8.4	-	8.4	8.8	0.57	6.5
1	-	9.2	9.2	-	-	-
2	20.1	-	20.1	19.4	1.15	5.9
2	18.5	-	18.5	-	-	-
2	17.6	-	17.6	-	-	-
2	18.3	-	18.3	-	-	-
2	-	20.8	20.8	-	-	-
2	-	19.7	19.7	-	-	-
2	-	19.5	19.5	-	-	-
2	-	20.6	20.6	-	-	-
4	40.2	-	40.2	39.0	2.98	7.6
4	37.2	-	37.2	-	-	-
4	33.2	-	33.2	-	-	-
4	37.8	-	37.8	-	-	-
4	-	41.6	41.6	-	-	-
4	-	41.9	41.9	-	-	-
4	-	38.3	38.3	-	-	-
4	-	41.6	41.6	-	-	-
5	51.6	-	51.6	53.3	2.29	4.3
5	52.0	-	52.0	-	-	-
5	50.7	-	50.7	-	-	-
5	51.4	-	51.4	-	-	-
5	-	54.1	54.1	-	-	-
5	-	57.3	57.3	-	-	-
5	-	53.8	53.8	-	-	-
5	-	55.5	55.5	-	-	-
6	56.8	-	56.8	57.1	3.36	5.9
6	56.6	-	56.6	-	-	-
6	54.8	-	54.8	-	-	-
6	54.8	-	54.8	-	-	-
6	53.6	-	53.6	-	-	-
6	52.6	-	52.6	-	-	-
6	52.4	-	52.4	-	-	-
6	-	59.8	59.8	-	-	-
6	-	62.8	62.8	-	-	-
6	-	61.2	61.2	-	-	-
6	-	60.5	60.5	-	-	-
6	-	60.1	60.1	-	-	-
6	-	58.0	58.0	-	-	-
6	-	55.2	55.2	-	-	-

TABLE 7. Oxidation of Fuel No. 15708 at 120°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
7	59.0	-	59.0	60.5	3.88	6.4
7	60.7	-	60.7	-	-	-
7	60.2	-	60.2	-	-	-
7	59.7	-	59.7	-	-	-
7	55.7	-	55.7	-	-	-
7	53.9	-	53.9	-	-	-
7	56.2	-	56.2	-	-	-
7	-	62.1	62.1	-	-	-
7	-	67.4	67.4	-	-	-
7	-	65.5	65.5	-	-	-
7	-	65.0	65.0	-	-	-
7	-	63.3	63.3	-	-	-
7	-	59.5	59.5	-	-	-
7	-	58.6	58.6	-	-	-
8	57.6	-	57.6	59.7	3.72	6.2
8	54.9	-	54.9	-	-	-
8	58.2	-	58.2	-	-	-
8	-	65.7	65.7	-	-	-
8	-	61.4	61.4	-	-	-
8	-	60.4	60.4	-	-	-
9	57.7	-	57.7	60.6	3.65	6.0
9	56.0	-	56.0	-	-	-
9	59.7	-	59.7	-	-	-
9	-	66.2	66.2	-	-	-
9	-	62.5	62.5	-	-	-
9	-	61.8	61.8	-	-	-
10	58.8	-	58.8	58.5	4.77	8.2
10	53.9	-	53.9	-	-	-
10	50.4	-	50.4	-	-	-
10	56.7	-	56.7	-	-	-
10	60.2	-	60.2	-	-	-
10	51.7	-	51.7	-	-	-
10	-	66.8	66.8	-	-	-
10	-	59.6	59.6	-	-	-
10	-	57.8	57.8	-	-	-
10	-	62.8	62.8	-	-	-
10	-	62.8	62.8	-	-	-
10	-	60.5	60.5	-	-	-
11	57.8	-	57.8	60.8	4.19	6.9
11	58.3	-	58.3	-	-	-
11	52.9	-	52.9	-	-	-
11	59.1	-	59.1	-	-	-
11	61.8	-	61.8	-	-	-
11	55.7	-	55.7	-	-	-
11	-	67.6	67.6	-	-	-
11	-	63.6	63.6	-	-	-
11	-	61.7	61.7	-	-	-
11	-	65.2	65.2	-	-	-

TABLE 7. Oxidation of Fuel No. 15708 at 120°C (Cont'd)

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
11	-	62.9	62.9	-	-	-
11	-	63.5	63.5	-	-	-
12	59.3	-	59.3	59.0	4.94	8.4
12	52.3	-	52.3	-	-	-
12	54.4	-	54.4	-	-	-
12	-	64.6	64.6	-	-	-
12	-	59.6	59.6	-	-	-
12	-	63.9	63.9	-	-	-
13	60.0	-	60.0	56.5	6.54	11.6
13	53.0	-	53.0	-	-	-
13	45.7	-	45.7	-	-	-
13	50.0	-	50.0	-	-	-
13	-	64.1	64.1	-	-	-
13	-	60.1	60.1	-	-	-
13	-	63.2	63.2	-	-	-
13	-	55.7	55.7	-	-	-
14	57.1	-	57.1	55.8	3.56	6.4
14	53.4	-	53.4	-	-	-
14	55.9	-	55.9	-	-	-
14	50.6	-	50.6	-	-	-
14	51.9	-	51.9	-	-	-
14	-	60.8	60.8	-	-	-
14	-	59.6	59.6	-	-	-
14	-	60.1	60.1	-	-	-
14	-	53.4	53.4	-	-	-
14	-	55.1	55.1	-	-	-
15	53.5	-	53.5	53.0	3.62	6.8
15	51.4	-	51.4	-	-	-
15	54.9	-	54.9	-	-	-
15	46.4	-	46.4	-	-	-
15	50.5	-	50.5	-	-	-
15	50.0	-	50.0	-	-	-
15	-	56.6	56.6	-	-	-
15	-	56.9	56.9	-	-	-
15	-	58.4	58.4	-	-	-
15	-	49.0	49.0	-	-	-
15	-	55.3	55.3	-	-	-
15	-	53.5	53.5	-	-	-
16	47.2	-	47.2	50.1	2.38	4.8
16	49.9	-	49.9	-	-	-
16	48.5	-	48.5	-	-	-
16	-	49.7	49.7	-	-	-
16	-	54.1	54.1	-	-	-
16	-	51.2	51.2	-	-	-
17	45.7	-	45.7	47.8	2.46	5.1
17	47.2	-	47.2	-	-	-
17	45.4	-	45.4	-	-	-
17	-	48.8	48.8	-	-	-

TABLE 7. Oxidation of Fuel No. 15708 at 120°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
17	-	52.1	52.1	-	-	-
17	-	47.4	47.4	-	-	-
18	43.6	-	43.6	43.0	3.51	8.2
18	44.5	-	44.5	-	-	-
18	39.5	-	39.5	-	-	-
18	43.3	-	43.3	-	-	-
18	39.0	-	39.0	-	-	-
18	-	45.8	45.8	-	-	-
18	-	48.5	48.5	-	-	-
18	-	37.8	37.8	-	-	-
18	-	44.6	44.6	-	-	-
19	42.2	42.2	41.1	2.24	5.5	
19	38.2	-	38.2	-	-	-
19	40.6	-	40.6	-	-	-
19	41.8	-	41.8	-	-	-
19	41.5	-	41.5	-	-	-
19	38.9	-	38.9	-	-	-
19	-	44.0	44.0	-	-	-
19	-	38.5	38.5	-	-	-
19	-	45.4	45.4	-	-	-
19	-	40.0	40.0	-	-	-
19	-	41.4	41.4	-	-	-
20	41.0	-	41.0	39.2	1.64	4.2
20	37.4	-	37.4	-	-	-
20	38.3	-	38.3	-	-	-
20	39.8	-	39.8	-	-	-
20	37.9	-	37.9	-	-	-
20	37.9	-	37.9	-	-	-
20	-	38.6	38.6	-	-	-
20	-	39.5	39.5	-	-	-
20	-	43.0	43.0	-	-	-
20	-	38.2	38.2	-	-	-
20	-	39.1	39.1	-	-	-
21	34.7	-	34.7	37.0	1.97	5.3
21	38.1	-	38.1	-	-	-
21	38.7	-	38.7	-	-	-
21	-	38.6	38.6	-	-	-
21	-	35.1	35.1	-	-	-
22	31.9	-	31.9	34.5	1.93	5.6
22	35.4	-	35.4	-	-	-
22	36.5	-	36.5	-	-	-
22	-	35.7	35.7	-	-	-
22	-	33.1	33.1	-	-	-
23	30.3	-	30.3	32.2	1.24	3.9
23	32.6	-	32.6	-	-	-
23	33.6	-	33.6	-	-	-
23	-	32.6	32.6	-	-	-
23	-	31.7	31.7	-	-	-

TABLE 7. Oxidation of Fuel No. 15708 at 120°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
24	27.7	-	27.7	29.2	1.75	6.0
24	30.1	-	30.1	-	-	-
24	31.7	-	31.7	-	-	-
24	-	27.5	27.5	-	-	-
24	-	29.0	29.0	-	-	-
25	27.8	-	27.8	28.0	0.32	1.1
25	28.2	-	28.2	-	-	-
25	28.4	-	28.4	-	-	-
25	-	27.9	27.9	-	-	-
25	-	27.6	27.6	-	-	-

Linear Regression Analysis of the Data

Equation	R^2	Source
Y = 8.2986*X +3.4351	0.970	Reactor-A
Y = 9.0205*X +3.8456	0.971	Reactor-B
Y = 8.6596*X +3.6404	0.962	Combined Data
Y = 8.9928*X +2.3257	0.980	Average Data

Notes:

Induction Period not resolved.
St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 8. Oxidation of Fuel No. 16581 at 80°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.6	-	0.6	0.9	0.32	35.6
0	0.7	-	0.7	-	-	-
0	-	1.2	1.2	-	-	-
0	-	1.2	1.2	-	-	-
10	2.0	-	2.0	2.1	0.07	3.3
10	-	2.1	2.1	-	-	-
20	2.0	-	2.0	2.2	-	-
20	-	2.4	2.4	-	-	-
25	2.3	-	2.3	2.5	0.17	6.8
25	2.5	-	2.5	-	-	-
25	-	2.4	2.4	-	-	-
25	-	2.7	2.7	-	-	-
30	2.5	-	2.5	2.7	0.21	7.8
30	-	2.8	2.8	-	-	-
35	3.6	-	3.6	3.8	0.28	7.4
35	-	4.0	4.0	-	-	-
40	3.5	-	3.5	4.0	0.49	12.3
40	-	4.2	4.2	-	-	-
45	3.4	-	3.4	3.2	0.28	8.8
45	-	3.0	3.0	-	-	-
50	3.8	-	3.8	4.6	0.74	16.1
50	4.5	-	4.5	-	-	-
50	-	4.6	4.6	-	-	-
50	-	5.6	5.6	-	-	-
60	4.5	-	4.5	5.1	0.78	15.3
60	-	5.6	5.6	-	-	-
65	5.4	-	5.4	6.0	0.85	14.2
65	-	6.6	6.6	-	-	-
70	5.3	-	5.3	6.1	1.06	17.4
70	-	6.8	6.8	-	-	-
75	6.5	-	6.5	7.8	1.19	15.3
75	7.1	-	7.1	-	-	-
75	-	8.6	8.6	-	-	-
75	-	9.0	9.0	-	-	-
80	8.0	-	8.0	9.3	1.84	19.8
80	-	10.6	10.6	-	-	-
85	7.2	-	7.2	9.4	3.11	33.1
85	-	11.6	11.6	-	-	-
90	8.8	-	8.8	11.9	4.31	36.2
90	-	14.9	14.9	-	-	-

TABLE 8. Oxidation of Fuel No. 16581 at 80°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-70 hours):		
Y = 0.06627*X +0.81356	0.963	Reactor-A
Y = 0.08154*X +0.93305	0.961	Reactor-B
Y = 0.07390*X +0.87331	0.918	Combined Data
Y = 0.07394*X +0.91422	0.914	Average
Post-Induction Period (70-90 hours):		
Y = 0.14308*X -4.1769	0.760	Reactor-A
Y = 0.37754*X -19.638	0.971	Reactor-B
Y = 0.26031*X -11.908	0.484	Combined Data
Y = 0.26400*X -12.220	0.943	Average

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 9. Oxidation of Fuel No. 16581 at 100°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	2.4	-	2.4	2.3	0.49	21.3
0	2.4	-	2.4	-	-	-
0	1.5	-	1.5	-	-	-
0	1.9	-	1.9	-	-	-
0	-	2.4	2.4	-	-	-
0	-	3.3	3.3	-	-	-
0	-	2.2	2.2	-	-	-
0	-	2.4	2.4	-	-	-
0	-	2.0	2.0	-	-	-
5	2.9	-	2.9	3.3	0.46	13.9
5	3.2	-	3.2	-	-	-
5	3.3	-	3.3	-	-	-
5	3.2	-	3.2	-	-	-
5	2.6	-	2.6	-	-	-
5	-	3.0	3.0	-	-	-
5	-	3.7	3.7	-	-	-
5	-	4.1	4.1	-	-	-
5	-	3.9	3.9	-	-	-
5	-	3.2	3.2	-	-	-
10	5.5	-	5.5	7.0	0.97	13.9
10	7.0	-	7.0	-	-	-
10	6.3	-	6.3	-	-	-
10	-	7.9	7.9	-	-	-
10	-	7.9	7.9	-	-	-
10	-	7.6	7.6	-	-	-
15	19.3	-	19.3	18.0	2.79	15.5
15	15.9	-	15.9	-	-	-
15	14.8	-	14.8	-	-	-
15	14.0	-	14.0	-	-	-
15	-	21.9	21.9	-	-	-
15	-	20.2	20.2	-	-	-
15	-	19.0	19.0	-	-	-
15	-	19.1	19.1	-	-	-
20	34.6	-	34.6	37.9	4.36	11.5
20	36.8	-	36.8	-	-	-
20	35.5	-	35.5	-	-	-
20	35.8	-	35.8	-	-	-
20	30.4	-	30.4	-	-	-
20	32.6	-	32.6	-	-	-
20	-	38.5	38.5	-	-	-
20	-	40.3	40.3	-	-	-
20	-	45.3	45.3	-	-	-
20	-	42.9	42.9	-	-	-

TABLE 9. Oxidation of Fuel No. 16581 at 100°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
20	-	40.5	40.5	-	-	-
20	-	41.1	41.1	-	-	-
25	49.1	-	49.1	53.1	3.99	7.5
25	48.9	-	48.9	-	-	-
25	49.5	-	49.5	-	-	-
25	52.2	-	52.2	-	-	-
25	48.5	-	48.5	-	-	-
25	-	53.6	53.6	-	-	-
25	-	58.1	58.1	-	-	-
25	-	57.9	57.9	-	-	-
25	-	56.3	56.3	-	-	-
25	-	57.1	57.1	-	-	-
30	51.7	-	51.7	57.4	4.98	8.7
30	52.7	-	52.7	-	-	-
30	54.7	-	54.7	-	-	-
30	-	59.9	59.9	-	-	-
30	-	61.7	61.7	-	-	-
30	-	63.5	63.5	-	-	-
35	56.2	-	56.2	61.6	4.48	7.3
35	57.7	-	57.7	-	-	-
35	59.1	-	59.1	-	-	-
35	-	63.9	63.9	-	-	-
35	-	66.1	66.1	-	-	-
35	-	66.5	66.5	-	-	-
40	61.1	-	61.1	61.9	-	-
40	56.9	-	56.9	-	-	-
40	-	66.4	66.4	-	-	-
40	-	62.9	62.9	-	-	-
40	-	62.4	62.4	-	-	-
45	60.7	-	60.7	60.8	-	-
45	57.6	-	57.6	-	-	-
45	-	63.4	63.0	-	-	-
45	-	59.5	59.5	-	-	-
45	-	63.4	63.4	-	-	-
50	58.1	-	58.1	55.7	-	-
50	50.4	-	50.4	-	-	-
50	-	56.4	56.9	-	-	-
50	-	56.9	56.9	-	-	-
50	-	56.4	56.4	-	-	-

TABLE 9. Oxidation of Fuel No. 16581 at 100°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-10 hours)		
Y = 0.40819*X +1.6458	0.836	Reactor-A
Y = 0.50300*X +1.9950	0.842	Reactor-B
Y = 0.45350*X +1.8366	0.796	Combined Data
Y = 0.47000*X +1.8500	0.901	Average Data
Post-Induction Period (10-25 hours):		
Y = 3.0155*X -26.300	0.976	Reactor-A
Y = 3.3904*X -27.810	0.982	Reactor-B
Y = 3.2029*X -27.057	0.951	Combined Data
Y = 3.1640*X -26.370	0.989	Average

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 10. Oxidation of Fuel No. 16581 at 120°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	2.1	-	2.1	1.7	0.59	34.7
0	2.1	-	2.1	-	-	-
0	1.1	-	1.1	-	-	-
0	-	2.3	2.3	-	-	-
0	-	1.9	1.9	-	-	-
0	-	0.9	0.9	-	-	-
1	3.5	-	3.5	3.5	0.07	2.0
1	-	3.4	3.4	-	-	-
2	11.0	-	11.0	9.8	1.32	13.5
2	10.0	-	10.0	-	-	-
2	9.1	-	9.1	-	-	-
2	-	11.1	11.1	-	-	-
2	-	10.2	10.2	-	-	-
2	-	7.6	7.6	-	-	-
3	22.0	-	22.0	20.8	1.77	8.5
3	-	19.5	19.5	-	-	-
4	36.6	-	36.6	37.5	2.38	6.4
4	36.4	-	36.4	-	-	-
4	37.3	-	37.3	-	-	-
4	-	39.3	39.3	-	-	-
4	-	34.2	34.2	-	-	-
5	48.1	-	48.1	46.7	2.05	4.4
5	-	45.2	45.2	-	-	-
6	53.3	-	53.3	53.4	0.66	1.2
6	52.8	-	52.8	-	-	-
6	52.8	-	52.8	-	-	-
6	-	53.6	53.6	-	-	-
6	-	54.4	54.4	-	-	-
7	56.1	-	56.1	57.1	1.41	2.5
7	-	58.1	58.1	-	-	-
8	58.2	-	58.2	57.4	3.43	6.0
8	51.9	-	51.9	-	-	-
8	54.1	-	54.1	-	-	-
8	58.4	-	58.4	-	-	-
8	61.1	-	61.1	-	-	-
8	-	62.2	62.2	-	-	-
8	-	54.3	54.3	-	-	-
8	-	57.4	57.4	-	-	-
8	-	59.2	59.2	-	-	-
8	-	59.9	59.9	-	-	-
10	54.6	-	54.6	56.5	2.67	4.7
10	55.2	-	55.2	-	-	-
10	-	55.6	55.6	-	-	-
10	-	60.4	60.4	-	-	-

TABLE 10. Oxidation of Fuel No. 16581 at 120°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
12	53.9	-	53.9	54.3	1.23	2.3
12	53.1	-	53.1	-	-	-
12	-	54.1	54.1	-	-	-
12	-	56.0	56.0	-	-	-
14	51.0	-	51.0	50.3	1.72	3.4
14	48.2	-	48.2	-	-	-
14	-	49.7	49.7	-	-	-
14	-	52.2	52.2	-	-	-
16	47.9	-	47.9	41.9	4.28	10.2
16	40.9	-	40.9	-	-	-
16	38.9	-	38.9	-	-	-
16	45.3	-	45.3	-	-	-
16	-	44.5	44.2	-	-	-
16	-	44.6	44.6	-	-	-
16	-	35.3	35.3	-	-	-
16	-	38.1	38.1	-	-	-
18	35.1	-	35.1	35.3	3.43	9.7
18	39.8	-	39.8	-	-	-
18	-	31.5	31.5	-	-	-
18	-	34.6	34.6	-	-	-
20	30.5	-	30.5	29.7	5.05	17.0
20	35.7	-	35.7	-	-	-
20	-	23.4	23.4	-	-	-
20	-	29.2	29.2	-	-	-
22	27.5	-	27.5	25.2	4.57	18.1
22	30.0	-	30.0	-	-	-
22	-	19.3	19.3	-	-	-
22	-	25.2	25.2	-	-	-
24	23.1	-	23.1	22.6	4.14	18.3
24	27.6	-	27.6	-	-	-
24	-	17.5	17.5	-	-	-
24	-	22.3	22.3	-	-	-
25	23.7	-	23.7	22.1	4.02	18.2
25	26.3	-	26.3	-	-	-
25	-	16.8	16.8	-	-	-
25	-	21.7	21.7	-	-	-

TABLE 10. Oxidation of Fuel No. 16581 at 120°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-1 hour):		
Y = 1.7333*X +1.7667	0.772	Reactor A
Y = 1.7000*X +1.7000	0.676	Reactor-B
Y = 1.7167*X +1.7333	0.720	Combined Data
Y = 1.8000*X +1.7000	1.000	Average Data
Post-Induction Period (1-7 hours):		
Y = 10.034*X -7.1364	0.968	Reactor-A
Y = 10.390*X -7.7612	0.947	Reactor-B
Y = 10.179*X -7.9659	0.970	Combined Data
Y = 9.7821*X -6.4429	0.970	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 11. Linear Regression Analysis of Oxidation of Fuel Nos. 15708 and 16581

			Induction Period			Post-Induction Period		
Fuel No.	Temp.,°C	Reactor	Time, hr	Equation	R^2	Max. hr	Equation	R^2
15708	43	Bottle	1932	Y = 0.0016*X -0.1435	0.878	8400	Y = 0.0012*X +0.1863	0.933
15708	80	Reactor-A	30	Y = 0.1131*X +0.8099	0.810	70	Y = 0.6371*X -18.566	0.921
15708	80	Reactor-B	30	Y = 0.1127*X +0.9854	0.929	70	Y = 0.6498*X -15.478	0.961
15708	80	A&B	30	Y = 0.1133*X +0.8916	0.850	70	Y = 0.6186*X -15.732	0.890
15708	80	Average	30	Y = 0.1164*X +0.8393	0.992	70	Y = 0.6397*X -16.539	0.928
15708	100	Reactor-A	---	---	---	25	Y = 2.3388*X +0.1688	0.980
15708	100	Reactor-B	---	---	---	25	Y = 2.5570*X -1.0096	0.986
15708	100	A&B	---	---	---	25	Y = 2.4745*X -0.5140	0.981
15708	100	Average	---	---	---	25	Y = 2.4846*X -0.5905	0.990
15708	120	Reactor-A	---	---	---	25	Y = 8.2986*X +3.4351	0.970
15708	120	Reactor-B	---	---	---	25	Y = 9.0205*X +3.8456	0.971
15708	120	A&B	---	---	---	25	Y = 8.6596*X +3.6404	0.962
15708	120	Average	---	---	---	25	Y = 8.9928*X +2.3257	0.980
16581	43	Bottle	5712	Y = 0.0065*X -7.7470	0.941	8400	Y = 0.0088*X -40.050	0.921
16581	80	Reactor-A	70	Y = 0.0663*X +0.8136	0.963	90	Y = 0.1431*X -4.1769	0.760
16581	80	Reactor-B	70	Y = 0.0815*X +0.9331	0.961	90	Y = 0.3775*X -19.638	0.971
16581	80	A&B	70	Y = 0.0739*X +0.8733	0.918	90	Y = 0.2603*X -11.908	0.484
16581	80	Average	70	Y = 0.0739*X +0.9142	0.914	90	Y = 0.2640*X -12.220	0.944
16581	100	Reactor-A	10	Y = 0.4082*X +1.6458	0.836	25	Y = 3.0155*X -26.300	0.976
16581	100	Reactor-B	10	Y = 0.5030*X +1.9950	0.842	25	Y = 3.3904*X -27.810	0.982
16581	100	A&B	10	Y = 0.4535*X +1.8366	0.796	25	Y = 3.2029*X -27.057	0.951
16581	100	Average	10	Y = 0.4700*X +1.8500	0.901	25	Y = 3.1640*X -26.370	0.989
16581	120	Reactor-A	1	Y = 1.7333*X +1.7667	0.772	7	Y =10.034*X -7.1364	0.968
16581	120	Reactor-B	1	Y = 1.7000*X +1.7000	0.676	7	Y =10.390*X -7.7612	0.947
16581	120	A&B	1	Y = 1.7167*X +1.7333	0.720	7	Y =10.179*X -7.9659	0.970
16581	120	Average	1	Y = 1.8000*X +1.7000	1.000	7	Y = 9.7821*X -6.4429	0.970

TABLE 12. Temperature Dependence of the Rates of Oxidation of Fuel Nos. 15708 and 16581 Based on $\ln k = \ln A - (E_a/RT)$

		ln k			
		Fuel No. 15708		Fuel No. 16581	
T,°C	(1/T) E3	IP	PIP	IP	PIP
43	3.165	-6.423	-5.040	-6.720	-4.737
80	2.833	-2.151	-0.447	-2.605	-1.332
100	2.681	0.910	0.910	-0.755	1.152
120	2.544	2.196	2.196	0.588	2.281

Regression Equation	R^2	E_a, kcal/mol/K	Reaction
Y = -14.28*X +38.70	0.990	28.37	15708 IP
Y = -11.74*X +32.35	0.988	23.33	15708 PIP
Y = -11.90*X +31.01	0.998	23.65	16581 IP
Y = -11.59*X +31.86	0.990	23.03	16581 PIP

Notes:

k = Average Global Rate Constant.
E_a = Activation Energy for Global Autoxidation.
IP = Induction Period.
PIP = Post-Induction Period.
R^2 = Coefficient of Determination.
K = Degrees Kelvin.

TABLE 13. Gas Chromatographic Conditions for the Analysis of Fuel Fractions

Gas Chromatograph	Hewlett-Packard Model 5890
Injector Temperature	300°C
Injector Split Ratio	100:1
Carrier Gas	Helium
Flow Rate at 150°C	0.65 mL He/min
Injection Volume	1 microliter
Column	50 m x 0.2 mm ID SE-54
Oven Temperature	Programmed
Initial Temperature	0°C
Initial Hold	0.00 min
Program Rate	3.0°C/min
Final Temperature	320°C
Final Hold	10 min

TABLE 14. Mass Spectrometer Operating Conditions

Solvent Delay	0.00 min
eM Volts	0 Relative
Resulting Voltage	1800
Start Time	0.00 min
Low Mass Limit	10 m/z
High Mass Limit	550 m/z
Scan Threshold	20 counts
a/d Samples (2 N)	2
Scans/Second	0.79

TABLE 15. Summary of Analysis of Nonpolar Fractions of Fuel Nos. 18496 and 18497

Compounds	Percent Area Under the Peak	
	Fuel No. 18496	Fuel No. 18497
Normal-paraffins, C_7-C_{21}	50.16	24.56
Iso-paraffins, C_8-C_{22}	30.80	16.53
Olefins	0.41	3.09
Cyclo-paraffins, c-C_5 + C_{3-5}	0.04	1.26
Cyclo-paraffins, c-C_6 + C_{2-5}	2.43	16.65
Cyclo-paraffins, c-C_6 + C_{6-13}	2.35	18.97
Methyl decalins	ND	4.78
Ethyl decalins	ND	2.76
Indane	ND	0.22
Total nonpolars identified, %	86.19	88.82

Note:

ND = Not Detected.

TABLE 16. Summary of Analysis of Polar Fractions of Fuel Nos. 18496 and 18497

Compounds	Percent Area Under the Peak	
	Fuel No. 18496	Fuel No. 18497
C_{1-2}-benzenes	5.27	ND
C_3-benzenes	12.75	1.49
C_4-benzenes	9.38	4.30
C_5-benzenes	1.12	11.57
C_6-benzenes	4.40	5.05
C_7-benzenes	3.16	8.53
C_8-benzenes	7.89	6.60
C_9-benzenes	ND	1.45
C_{10}-benzene	0.30	ND
C_{11}-benzenes	0.26	ND
Total benzenes	44.53	38.99
Tetralin	ND	1.36
C_1-tetralin	ND	0.73
C_2-tetralins	13.72	1.45
C_3-tetralins	1.76	7.30
C_4-tetralins	8.08	7.31
C_5-tetralins	ND	3.60
Total tetralins	23.56	21.75
C_1-naphthalene	ND	0.96
C_3-naphthalenes	ND	1.64
C_4-naphthalenes	1.92	ND
C_5-naphthalenes	1.22	0.36
Total naphthalenes	3.14	2.96
Decalins	ND	0.10
C_3-biphenyls	ND	0.16
Indane	ND	0.11
C_1-indane	4.13	0.49
C_2-indane	7.82	4.11
C_3-indane	ND	2.17
C_{2-3}-fluorenes	1.53	ND
C_{2-3}-diphenylmethanes	2.56	ND
Total polars identified, %	87.27	70.84

Note:

ND = Not Detected.

TABLE 17. Oxidation of Fuel No. 18496 at 80°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	-	-	-
5	0.0	-	0.0	0.0	0.00	0.0
5	-	0.0	0.0	-	-	-
10	0.0	-	0.0	0.0	-	-
15	0.7	-	0.7	0.4	0.49	12.3
15	0.0	-	0.0	-	-	-
20	0.4	-	0.4	0.1	0.23	230.0
20	0.0	-	0.0	-	-	-
20	-	0.0	0.0	-	-	-
25	0.5	-	0.5	0.3	0.35	113.7
25	-	0.0	0.0	-	-	-
40	0.0	-	0.0	0.0	-	-
45	1.0	-	1.0	0.7	0.25	35.7
45	0.5	-	0.5	-	-	-
45	-	0.7	0.7	-	-	-
50	1.3	-	1.3	1.1	0.28	25.5
50	-	0.9	0.9	-	-	-
55	-	1.0	1.0	1.0	-	-
60	-	0.8	0.8	0.8	-	-
70	1.6	-	1.6	1.5	0.21	14.0
70	-	1.3	1.3	-	-	-
75	1.7	-	1.7	1.6	0.21	13.1
75	-	1.4	1.4	-	-	-
80	-	1.5	1.5	1.5	-	-
85	3.0	-	3.0	2.5	0.71	28.4
85	-	2.0	2.0	-	-	-
90	3.1	-	3.1	3.1	-	-
95	2.6	-	2.6	2.2	0.38	17.3
95	-	1.9	1.9	-	-	-
95	-	2.0	2.0	-	-	-
100	2.9	-	2.9	2.6	0.42	16.2
100	-	2.3	2.3	-	-	-
105	-	3.0	3.0	3.0	-	-
110	4.5	3.3	4.5	3.9	0.85	21.8
110	4.0	-	4.0	-	-	-
110	-	-	3.3	-	-	-
115	5.2	-	5.2	4.9	0.42	8.6
115	4.6	-	4.6	-	-	-
120	-	3.3	3.3	3.3	-	-
125	-	3.8	3.8	3.8	-	-
130	6.3	-	6.3	5.5	1.13	20.6
130	-	4.7	4.7	-	-	-
135	7.1	-	7.1	5.9	1.08	18.3
135	5.6	-	5.6	-	-	-
135	-	5.0	5.0	-	-	-
140	6.1	-	6.1	5.4	1.06	19.6
140	-	4.6	4.6	-	-	-

TABLE 17. Oxidation of Fuel No. 18496 at 80°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
145	-	5.0	5.0	5.0	-	-
150	-	6.2	6.2	6.2	-	-
155	10.0	-	10.0	8.7	1.91	22.0
155	-	7.3	7.3	-	-	-
160	11.6	-	11.6	10.3	1.91	18.5
160	8.9	-	8.9	-	-	-
165	9.3	-	9.3	8.0	1.77	22.1
165	-	6.8	6.8	-	-	-
170	-	7.2	7.2	7.2	-	-
180	20.0	-	20.0	20.0	-	-
185	25.1	-	25.1	19.1	8.56	44.8
185	13.0	-	13.0	-	-	-
210	31.8	-	31.8	31.8	-	-
215	38.0	-	38.0	38.0	-	-

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-150 hours):		
Y = 0.046021*X -0.7224	0.904	Reactor-A
Y = 0.039230*X -1.0227	0.904	Reactor-B
Y = 0.041373*X -0.7850	0.861	Combined Data
Y = 0.041520*X -0.8835	0.893	Average Data
Post-Induction Period (150-210 hours):		
Y = 0.46260*X -64.378	0.880	Reactor-A
Y = 0.47054*X -66.605	0.863	Combined Data
Y = 0.48271*X -68.690	0.928	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 18. Oxidation of Fuel No. 18496 at 100 °C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.6	-	0.6	0.9	0.29	32.2
0	0.9	-	0.9	-	-	-
0	1.3	-	1.3	-	-	-
0	-	0.8	0.8	-	-	-
5	1.5	-	1.5	1.8	0.25	13.9
5	1.8	-	1.8	-	-	-
5	-	2.1	2.1	-	-	-
5	-	1.9	1.9	-	-	-
10	3.0	-	3.0	3.3	0.44	13.3
10	3.1	-	3.1	-	-	-
10	3.2	-	3.2	-	-	-
10	-	2.9	2.9	-	-	-
10	-	3.7	3.7	-	-	-
10	-	4.0	4.0	-	-	-
15	4.8	-	4.8	5.2	0.65	12.5
15	5.0	-	5.0	-	-	-
15	5.4	-	5.4	-	-	-
15	-	4.4	4.4	-	-	-
15	-	5.2	5.2	-	-	-
15	-	6.3	6.3	-	-	-
20	6.6	-	6.6	8.0	1.07	13.4
20	8.1	-	8.1	-	-	-
20	-	8.2	8.2	-	-	-
20	-	9.2	9.2	-	-	-
25	18.5	-	18.5	18.6	1.65	8.9
25	18.5	-	18.5	-	-	-
25	-	17.7	17.7	-	-	-
25	-	17.1	17.1	-	-	-
25	-	21.4	21.4	-	-	-
30	39.2	-	39.2	38.9	0.49	1.3
30	-	38.5	38.5	-	-	-
35	52.7	-	52.7	54.4	3.02	5.6
35	51.8	-	51.8	-	-	-
35	58.9	-	58.9	-	-	-
35	-	52.5	52.5	-	-	-
35	-	56.1	56.1	-	-	-
40	64.9	-	64.9	63.3	2.29	3.6
40	63.5	-	63.5	-	-	-
40	-	60.0	60.0	-	-	-
40	-	64.8	64.8	-	-	-
45	58.8	-	58.8	60.4	2.26	3.7
45	-	62.0	62.0	-	-	-
50	56.9	-	56.9	60.6	3.33	5.5
50	63.3	-	63.3	-	-	-
50	-	61.7	61.7	-	-	-

TABLE 18. Oxidation of Fuel No. 18496 at 100°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-20 hours):		
Y = 0.31444*X +0.46111	0.937	Reactor-A
Y = 0.39326*X -0.04157	0.905	Reactor-B
Y = 0.34884*X +0.28287	0.908	Combined Data
Y = 0.35200*X +0.32000	0.960	Average Data
Post-Induction Period (20-40 hours):		
Y = 3.01943*X -53.82	0.980	Reactor-A
Y = 2.88756*X -50.63	0.976	Reactor-B
Y = 2.95714*X -52.30	0.978	Combined Data
Y = 2.92800*X -51.20	0.985	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 19. Oxidation of Fuel No. 18496 at 120°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	0.0	-	0.0	0.0	0.00
0	-	0.0	0.0	-	-
1	1.5	-	1.5	1.6	0.07
1	-	1.6	1.6	-	-
2	3.0	-	3.0	3.0	0.00
2	-	3.0	3.0	-	-
3	5.7	-	5.7	5.7	0.07
3	-	5.6	5.6	-	-
4	11.0	-	11.0	10.8	0.35
4	-	10.5	10.5	-	-
5	23.3	-	23.3	22.9	0.64
5	-	22.4	22.4	-	-
6	38.6	-	38.6	37.2	2.05
6	-	35.7	35.7	-	-
7	51.4	-	51.4	50.4	1.48
7	-	49.3	49.3	-	-
8	61.2	-	61.2	60.9	0.49
8	-	60.5	60.5	-	-

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-4 hours):		
Y = 2.6050*X -1.3300	0.885	Reactor-A
Y = 2.5750*X -1.3100	0.882	Reactor-B
Y = 2.5900*X -1.3200	0.884	Combined Data
Y = 2.5900*X -1.3000	0.898	Average Data
Post-Induction Period (4-8 hours):		
Y = 12.845*X -41.030	0.992	Reactor-A
Y = 13.145*X -43.140	0.994	Reactor-B
Y = 12.995*X -42.085	0.993	Combined Data
Y = 13.010*X -42.160	0.997	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 20. Oxidation of Fuel No. 18497 at 80°C

Stress Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
	(Peroxides, ppm)$^{1/2}$					
0	1.8	-	1.8	1.6	0.35	21.9
0	-	1.3	1.3	-	-	-
5	0.9	-	0.9	0.8	0.21	26.3
5	-	0.6	0.6	-	-	-
10	0.0	-	0.0	0.7	0.48	68.6
10	-	1.1	1.1	-	-	-
15	0.8	-	0.8	0.6	0.28	46.7
15	-	0.4	0.4	-	-	-
20	0.8	-	0.8	0.8	0.00	0.0
20	-	0.8	0.8	-	-	-
25	0.9	-	0.9	0.9	0.07	7.8
25	-	0.8	0.8	-	-	-
45	1.8	-	1.8	1.5	0.49	32.7
45	-	1.1	1.1	-	-	-
50	1.9	-	1.9	1.7	0.28	16.5
50	-	1.5	1.5	-	-	-
55	1.9	-	1.9	2.2	0.35	15.9
55	-	2.4	2.4	-	-	-
60	2.1	-	2.1	2.1	0.00	0.0
60	-	2.1	2.1	-	-	-
70	3.5	-	3.5	2.9	0.85	29.3
70	-	2.3	2.3	-	-	-
75	4.1	-	4.1	3.3	1.13	34.2
75	-	2.5	2.5	-	-	-
80	2.4	-	2.4	2.9	0.71	24.5
80	-	3.4	3.4	-	-	-
85	3.1	-	3.1	3.7	0.57	15.4
85	3.3	-	3.3	-	-	-
85	-	3.6	3.6	-	-	-
85	-	4.1	4.1	-	-	-
90	3.9	-	3.9	4.2	0.42	10.0
90	-	4.5	4.5	-	-	-
95	7.7	-	7.7	6.0	2.47	41.2
95	-	4.2	4.2	-	-	-
100	9.4	-	9.4	7.2	3.11	43.2
100	-	5.0	5.0	-	-	-
105	5.2	-	5.2	6.0	1.06	17.7
105	-	6.7	6.7	-	-	-
110	5.7	-	5.7	6.8	1.41	20.7
110	5.4	-	5.4	-	-	-
110	-	8.2	8.2	-	-	-
110	-	7.7	7.7	-	-	-
115	6.1	-	6.1	7.5	1.91	25.5
115	-	8.8	8.8	-	-	-

TABLE 20. Oxidation of Fuel No. 18497 at 80°C (Cont'd)

Stress Time, hr	$(\text{Peroxides, ppm})^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
130	10.7	-	10.7	11.9	1.63	13.7
130	-	13.0	13.0	-	-	-
135	11.9	-	11.9	13.4	2.12	15.8
135	-	14.9	14.9	-	-	-
155	19.6	-	19.6	20.0	0.49	2.5
155	-	20.3	20.3	-	-	-
160	21.7	-	21.7	22.0	0.35	1.6
160	-	22.2	22.2	-	-	-
180	24.1	-	24.1	23.9	0.35	1.5
180	-	23.6	23.6	-	-	-
185	25.9	-	25.9	24.9	1.48	5.9
185	-	23.8	23.8	-	-	-

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-85 hours):		
Y = 0.03226*X +0.49092	0.712	Reactor-A
Y = 0.33975*X +0.32647	0.797	Reactor-B
Y = 0.31855*X +0.48187	0.819	Average
Post-Induction Period (85-185 hours):		
Y = 0.22885*X -17.159	0.928	Reactor-A
Y = 0.22602*X -16.352	0.977	Reactor-B
Y = 0.22830*X -16.773	0.973	Average

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 21. Oxidation of Fuel No. 18497 at 100°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.3	-	0.3	0.9	0.77	85.6
0	0.0	-	0.0	-	-	-
0	0.8	-	0.8	-	-	-
0	1.1	-	1.1	-	-	-
0	0.0	-	0.0	-	-	-
0	-	1.8	1.8	-	-	-
0	-	1.3	1.3	-	-	-
0	-	1.2	1.2	-	-	-
0	-	2.1	2.1	-	-	-
0	-	0.0	0.0	-	-	-
5	1.6	-	1.6	1.5	0.50	33.3
5	0.6	-	0.6	-	-	-
5	1.4	-	1.4	-	-	-
5	1.5	-	1.5	-	-	-
5	0.9	-	0.9	-	-	-
5	-	2.0	2.0	-	-	-
5	-	1.7	1.7	-	-	-
5	-	1.9	1.9	-	-	-
5	-	2.2	2.2	-	-	-
5	-	1.1	1.1	-	-	-
10	1.6	-	1.6	2.7	1.18	43.7
10	4.7	-	4.7	-	-	-
10	2.7	-	2.7	-	-	-
10	1.8	-	1.8	-	-	-
10	-	3.5	3.5	-	-	-
10	-	2.1	2.1	-	-	-
15	3.5	-	3.5	5.3	1.65	31.1
15	8.4	-	8.4	-	-	-
15	5.1	-	5.1	-	-	-
15	4.5	-	4.5	-	-	-
15	-	5.5	5.5	-	-	-
15	-	5.0	5.0	-	-	-
20	8.7	-	8.7	8.9	2.31	26.0
20	6.3	-	6.3	-	-	-
20	-	11.9	11.9	-	-	-
20	-	8.5	8.5	-	-	-
25	18.8	-	18.8	17.4	2.76	15.9
25	15.4	-	15.4	-	-	-
25	16.7	-	16.7	-	-	-
25	-	19.6	19.6	-	-	-
25	-	20.7	20.7	-	-	-
25	-	13.4	13.4	-	-	-

TABLE 21. Oxidation of Fuel No. 18497 at 100°C (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
30	26.2	-	26.2	25.3	4.22	16.7
30	25.1	-	25.1	-	-	-
30	20.0	-	20.0	-	-	-
30	-	31.6	31.6	-	-	-
30	-	23.7	23.7	-	-	-
35	30.2	-	30.2	30.6	3.60	11.8
35	30.1	-	30.1	-	-	-
35	25.4	-	25.4	-	-	-
35	-	35.3	35.3	-	-	-
35	-	32.1	32.1	-	-	-
40	34.3	-	34.3	35.5	4.73	13.3
40	30.1	-	30.1	-	-	-
40	-	41.5	41.5	-	-	-
40	-	36.1	36.1	-	-	-
45	35.1	-	35.1	37.9	2.47	6.5
45	-	39.6	39.6	-	-	-
45	-	39.1	39.1	-	-	-
50	39.9	-	39.9	43.4	4.29	9.9
50	38.7	-	38.7	-	-	-
50	38.7	-	38.7	-	-	-
50	-	44.8	44.8	-	-	-
50	-	45.3	45.3	-	-	-
50	-	46.9	46.9	-	-	-
50	-	49.4	49.4	-	-	-
55	43.9	-	43.9	47.9	5.00	10.4
55	43.2	-	43.2	-	-	-
55	-	52.0	52.0	-	-	-
55	-	52.4	52.4	-	-	-

TABLE 21. Oxidation of Fuel No. 18497 at 100°C (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-15 hours):		
Y = 0.32185*X +0.0150	0.695	Reactor-A
Y = 0.24057*X +0.9541	0.750	Reactor-B
Y = 0.28329*X +0.4763	0.682	Combined Data
Y = 0.28800*X +0.4400	0.909	Average Data
Post-Induction Period (15-40 hours):		
Y = 1.15922*X -12.52	0.942	Reactor-A
Y = 1.42070*X -16.87	0.944	Reactor-B
Y = 1.27511*X -14.43	0.921	Combined Data
Y = 1.28000*X -14.70	0.988	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 22. Oxidation of Fuel No. 18497 at 120°C

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	1.5	-	1.5	1.3	0.44
0	-	1.6	1.6	-	-
0	-	0.8	0.8	-	-
1	2.3	-	2.3	2.4	0.23
1	-	2.3	2.3	-	-
1	-	2.7	2.7	-	-
2	4.6	-	4.6	4.4	0.21
2	-	4.2	4.2	-	-
2	-	4.5	4.5	-	-
3	9.3	-	9.3	9.1	0.67
3	-	8.4	8.4	-	-
3	-	9.7	9.7	-	-
4	20.7	-	20.7	20.1	2.11
4	-	17.8	17.8	-	-
4	-	21.9	21.9	-	-
5	29.9	-	29.9	29.7	1.96
5	-	27.6	27.6	-	-
5	-	31.5	31.5	-	-
6	39.0	-	39.0	39.7	2.72
6	-	37.4	37.4	-	-
6	-	42.7	42.7	-	-
7	46.3	-	46.3	45.7	0.92
7	-	45.0	45.0	-	-
8	54.4	-	54.4	53.9	0.78
8	-	53.3	53.3	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-02 hours):		
Y = 1.5500*X +1.2500	0.928	Reactor-A
Y = 1.5750*X +1.1083	0.948	Reactor-B
Y = 1.5667*X +1.1556	0.939	Combined Data
Y = 1.5500*X +1.1500	0.973	Average Data
Post-Induction Period (2-8 hours):		
Y = 8.6321*X -13.989	0.995	Reactor-A
Y = 8.6680*X -14.395	0.979	Reactor-B
Y = 8.6596*X -14.272	0.986	Combined Data
Y = 8.6179*X -14.61	0.993	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 23. Linear Regression Analysis of Oxidation of Fuel Nos. 18496 and 18497

			Induction Period			Post-Induction Period		
Fuel No.	Temp., °C	Reactor	Time, hr.	Equation	R^2	Max. hr.	Equation	R^2
18496	80	Reactor-A	150	Y = 0.0460*X -0.7224	0.904	210	Y = 0.4626*X -64.378	0.880
18496	80	Reactor-B	150	Y = 0.0392*X -1.0227	0.904	210	--	--
18496	80	A&B	150	Y = 0.0414*X -0.7850	0.861	210	Y = 0.4705*X -68.690	0.928
18496	80	Average	150	Y = 0.0415*X -0.8835	0.893	210	Y = 0.4827*X -68.690	0.928
18496	100	Reactor-A	20	Y = 0.3144*X +0.4611	0.937	40	Y = 3.0194*X -53.820	0.980
18496	100	Reactor-B	20	Y = 0.3933*X +0.0416	0.905	40	Y = 2.8876*X -50.630	0.976
18496	100	A&B	20	Y = 0.3488*X +0.2829	0.908	40	Y = 2.9571*X -52.300	0.978
18496	100	Average	20	Y = 0.3520*X +0.3200	0.960	40	Y = 2.9280*X -51.200	0.985
18496	120	Reactor-A	4	Y = 2.6050*X -1.3300	0.885	8	Y = 12.845*X -41.030	0.992
18496	120	Reactor-B	4	Y = 2.5750*X -1.3100	0.882	8	Y = 13.145*X -43.140	0.994
18496	120	A&B	4	Y = 2.5900*X -1.3200	0.884	8	Y = 12.995*X -42.085	0.993
18496	120	Average	4	Y = 2.5900*X -1.3000	0.898	8	Y = 13.010*X -42.160	0.997
18497	80	Reactor-A	85	y = 0.0323*X -0.7224	0.904	185	Y = 0.2289*X -17.159	0.928
18497	80	Reactor-B	85	Y = 0.3398*X +0.3265	0.797	185	Y = 0.2260*X -16.352	0.977
18497	80	Average	85	Y = 0.3186*X +0.4819	0.819	185	Y = 0.2283*X -16.773	0.973
18497	100	Reactor-A	15	Y = 0.3219*X +0.0150	0.695	40	Y = 1.1592*X -12.520	0.942
18497	100	Reactor-B	15	Y = 0.2406*X +0.9541	0.750	40	Y = 1.4207*X -16.870	0.944
18497	100	A&B	15	Y = 0.2833*X +0.4763	0.682	40	Y = 1.2751*X -14.430	0.921
18497	100	Average	15	Y = 0.2880*X +0.4400	0.909	40	Y = 1.2800*X -14.700	0.988
18497	120	Reactor-A	2	Y = 1.5500*X +1.2500	0.928	8	Y = 8.6321*X -13.989	0.995
18497	120	Reactor-B	2	Y = 1.5750*X +1.1083	0.948	8	Y = 8.6680*X -14.395	0.979
18497	120	A&B	2	Y = 1.5667*X +1.1556	0.939	8	Y = 8.6596*X -14.272	0.986
18497	120	Average	2	Y = 1.5500*X +1.1500	0.973	8	Y = 8.6179*X -14.610	0.993

TABLE 23. Linear Regression Analysis of Oxidation of Fuel Nos. 18496 and 18497 (Cont'd)

			Induction Period			Post-Induction Period		
Fuel No.	Temp., °C	Reactor	Time, hr.	Equation	R^2	Max. hr.	Equation	R^2
2nd Run of 18497 at 100°C								
18497	100	Reactor-A	20	Y = 0.2855*X +0.3492	0.898	40	Y = 1.4914*X -23.660	0.998
18497	100	Reactor-B	20	Y = 0.2548*X +0.7337	0.904	40	Y = 2.0236*X -36.430	0.947
18497	100	A&B	20	Y = 0.2675*X +0.5881	0.899	40	Y = 1.6431*X -268260	0.939
18497	100	Average	20	Y = 0.2820*X +0.5200	0.923	40	Y = 1.5760*X -25.220	0.974

TABLE 24. Linear Regression Analysis of the Arrhenius Plot of Fuel Nos. 18496 and 18497 Based on ln k = ln A - (E_a/RT)

		ln k			
		Fuel No. 15708		Fuel No. 16581	
T,°C	(1/T) E3	IP	PIP	IP	PIP
80	2.8321	-3.1816	-0.7284	-3.4467	-1.4771
100	2.6802	-1.0441	1.0743	-1.2448	0.2469
120	2.5439	0.9517	2.5657	0.4383	2.1538

Regression Equation	R^2	E_a, kcal/mol/K	Reaction
Y = -14.34*X +37.41	1.000	28.49	18496, IP
Y = -11.44*X +31.69	0.999	22.73	18496, PIP
Y = -13.50*X +34.83	0.998	26.82	18497, IP
Y = -12.57*X +34.08	0.996	24.98	18497, PIP

Notes:

k = Average Global Rate Constant.
E_a = Activation Energy for Global Autoxidation.
IP = Induction Period.
PIP = Post-Induction Period.
R^2 = Coefficient of Determination.
K = Degrees Kelvin.

TABLE 25. Identification of Antioxidants

A. 2,6-di-tert-butyl-4-methylphenol

B. 6-tert-butyl-2,4-dimethylphenol

C. 2,6-di-tert-butylphenol

D. 75 percent min 2,6-di-tert-butylphenol
25 percent max tert-butylphenols and tri-tert-butylphenols

E. 72 percent min 6-tert-butyl-2,4-dimethylphenol
28 percent max tert-butyl-methylphenols and tert-butyl-dimethylphenols

F. 55 percent min 6-tert-butyl-2,4-dimethylphenol
45 percent max mixture of tert-butylphenols and di-tert-butylphenols

G. 60 to 80 percent 2,6-dialkylphenols
20 to 40 percent mixture of 2,3,6-trialkylphenols and 2,4,6-trialkylphenols

H. 35 percent min 2,6-di-tert-butyl-4-methylphenol
65 percent max mixture of methyl-, ethyl-, and dimethyl-tert-butylphenols

I. 60 percent min 2,4-di-tert-butylphenol
40 percent max mixture of tert-butylphenols

J. 30 percent min mixture of 2,3,6-trimethylphenol and 2,4,6-tri-methylphenol
70 percent max mixture of dimethylphenols

K. This antioxidant blend was dropped from the test matrix.

L. 55 percent min butylated ethyl phenols
45 percent max butylated methyl and dimethyl phenols

M. 45 percent min 4,6-di-tert-butyl-2-methylphenol 40 percent min mixture of 6-tert-butyl-2-methylphenol and 2,4,6-tri-tertbutylphenol
15 percent max mixture of other butylated phenols

N. 75 percent min mixture of di- and tri-isopropylphenols
25 percent max mixture of di- and tri-tert-butylphenols

TABLE 26. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "A"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	0.0	-	0.0	-	-	-
0	-	0.0	0.0	-	-	-
0	-	0.0	0.0	-	-	-
5	0.0	-	0.0	0.4	0.69	172.5
5	-	0.0	0.0	-	-	-
5	-	1.2	1.2	-	-	-
10	1.5	-	1.5	1.6	0.14	8.8
10	-	1.7	1.7	-	-	-
15	2.0	-	2.0	1.6	0.4	25.0
15	1.2	-	1.2	-	-	-
15	-	1.5	1.5	-	-	-
20	1.9	-	1.9	2.0	0.07	3.5
20	-	2.0	2.0	-	-	-
25	2.0	-	2.0	2.2	0.28	12.7
25	-	2.4	2.4	-	-	-
30	2.6	-	2.6	3.2	0.67	20.9
30	-	3.0	3.0	-	-	-
30	-	3.9	3.9	-	-	-
35	3.6	4.5	3.6	4.1	0.64	15.6
35	-	4.5	4.5	-	-	-
40	4.9	-	4.9	4.3	0.49	11.4
40	4.1	-	4.1	-	-	-
40	-	4.0	4.0	-	-	-
45	5.8	-	5.8	5.9	0.07	1.2
45	-	5.9	5.9	-	-	-
50	4.9	-	4.9	5.1	0.21	4.1
50	-	5.2	5.2	-	-	-
55	5.9	-	5.9	7.4	2.05	27.7
55	-	8.8	8.8	-	-	-
60	24.7	-	24.7	24.7	-	-
65	44.1	-	44.1	40.8	3.35	8.2
65	41.0	-	41.0	-	-	-
65	-	37.4	37.4	-	-	-
70	55.3	-	55.3	56.6	1.77	3.1
70	-	57.8	57.8	-	-	-
85	57.4	-	57.4	57.4	-	-
120	23.1	-	23.1	25.5	3.39	13.3
120	-	27.9	27.9	-	-	-

TABLE 26. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "A" (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-55 hours):		
Y = 0.1107*X -0.1484	0.947	Reactor-A
Y = 0.1292*X -0.2040	0.906	Reactor-B
Y = 0.1196*X -0.1739	0.909	Combined Data
Y = 0.1183*X -0.1436	0.959	Average Data
Post-Induction Period (55-70 hours):		
Y = 3.3538*X -177.1	0.988	Reactor-A
Y = 3.2086*X -168.5	0.991	Reactor-B
Y = 3.2835*X -172.9	0.989	Combined Data
Y = 3.3040*X -174.2	0.999	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 27. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "B"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.7	-	0.7	0.5	0.28	56.0
0	-	0.3	0.3	-	-	-
5	1.4	-	1.4	1.4	0.07	5.0
5	-	1.3	1.3	-	-	-
10	2.4	-	2.4	2.4	0.07	2.9
10	-	2.3	2.3	-	-	-
15	2.8	-	2.8	3.1	0.35	11.3
15	-	3.3	3.3	-	-	-
20	3.1	-	3.1	3.1	-	-
25	4.1	-	4.1	4.0	0.14	3.5
25	-	3.9	3.9	-	-	-
30	4.8	-	4.8	5.0	0.28	5.6
30	-	5.2	5.2	-	-	-
35	6.6	-	6.6	7.4	2.06	27.8
35	5.8	-	5.8	-	-	-
40	8.0	-	8.0	8.4	0.57	6.8
40	-	8.8	8.8	-	-	-
45	11.7	-	11.7	13.1	1.98	15.1
45	-	14.5	14.5	-	-	-
50	24.2	-	24.2	26.2	5.05	19.3
50	22.4	-	22.4	-	-	-
50	-	31.9	31.9	-	-	-
55	43.2	-	43.2	45.5	3.25	7.1
55	-	47.8	47.8	-	-	-
60	59.0	-	59.0	61.9	2.81	4.5
60	-	62.1	62.1	-	-	-
60	-	64.6	64.6	-	-	-
65	66.9	-	66.9	64.4	3.54	5.5
65	-	61.9	61.9	-	-	-

TABLE 27. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "B" (Cont'd)

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-45 hours):		
Y = 0.2028* X -0.1208	0.877	Reactor-A
Y = 0.2693* X -0.6562	0.867	Reactor-B
Y = 0.2339* X -0.4028	0.837	Combined Data
Y = 0.2352* X -0.4509	0.872	Average Data
Post-Induction Period (45-65 hours):		
Y = 2.9668*X -122.8	0.982	Reactor-A
Y = 2.6302*X -99.7	0.916	Reactor-B
Y = 2.8400*X -113.7	0.938	Combined Data
Y = 2.7660*X -109.9	0.959	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 28. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "C"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.3	0.35	116.7
0	-	0.5	0.5	-	-	-
5	0.0	-	0.0	0.9	0.95	105.6
5	-	0.9	0.9	-	-	-
5	-	1.9	1.9	-	-	-
10	2.1	-	2.1	2.2	0.14	6.4
10	-	2.3	2.3	-	-	-
15	2.7	-	2.7	2.7	-	-
20	-	3.5	3.5	3.5	-	-
25	4.1	-	4.1	4.3	0.21	4.9
25	-	4.4	4.4	-	-	-
30	5.1	-	5.1	5.5	0.57	10.4
30	-	5.9	5.9	-	-	-
35	6.1	-	6.1	7.5	1.98	26.4
35	-	8.9	8.9	-	-	-
40	8.4	-	8.4	8.4	-	-
45	-	20.1	20.1	20.1	-	-
50	40.4	-	40.4	41.6	1.7	4.1
50	-	42.8	42.8	-	-	-
55	52.4	-	52.4	52.4	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-40 hours):		
Y = 0.1977*X -0.3908	0.965	Reactor-A
Y = 0.2068*X +0.1763	0.916	Reactor-B
Y = 0.1977*X -0.0337	0.923	Combined Data
Y = 0.2013*X -0.1044	0.975	Average Data
Post-Induction Period (40-55 hours):		
Y = 2.9714X -109.9	0.996	Reactor-A
Y = 3.1208X -117.0	0.975	Combined Data
Y = 3.0700X -115.2	0.982	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 29. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "D"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.4	0.49	122.5
0	-	0.7	0.7	-	-	-
5	0.9	-	0.9	1.3	0.49	37.7
5	-	1.6	1.6	-	-	-
10	2.6	-	2.6	2.4	0.35	14.6
10	2.1	-	2.1	-	-	-
15	3.2	-	3.2	3.1	0.14	4.5
15	3.0	-	3.0	-	-	-
16	-	2.9	2.9	-	-	-
20	3.1	-	3.1	3.4	0.35	10.3
20	-	3.6	3.6	-	-	-
25	3.9	-	3.9	4.6	0.92	20.0
25	-	5.2	5.2	-	-	-
30	-	6.6	6.6	6.6	-	-
35	9.5	-	9.5	10.6	1.48	14.0
35	11.6	-	11.6	-	-	-
40	13.7	-	13.7	16.7	5.34	32.0
40	-	13.6	13.6	-	-	-
40	22.9	-	22.9	-	-	-
45	-	33.0	33.0	33.0	-	-
50	44.1	-	44.1	48.7	6.51	13.4
50	-	53.3	53.3	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-30 hr):		
Y = 0.1533X +0.4333	0.892	Reactor-A
Y = 0.1863X +0.4530	0.957	Reactor-B
Y = 0.1780X +0.3227	0.916	Combined Data
Y = 0.1871X +0.3071	0.957	Average Data
Post-Induction Period (35-50 hr):		
Y = 2.2367X -69.11	0.928	Reactor-A
Y = 3.9700X -145.3	0.999	Reactor-B
Y = 2.6544X -85.94	0.910	Combined Data
Y = 2.6120X -83.76	0.967	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination or squared correlation coefficient.

TABLE 30. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "E"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
5	1.0	-	1.0	1.1	0.14	12.7
5	-	1.2	1.2	-	-	-
10	-	2.1	2.1	1.9	-	-
10	1.7	-	1.7	-	-	-
15	-	3.0	3.0	2.6	0.40	15.4
15	-	2.7	2.7	-	-	-
15	2.2	-	2.2	-	-	-
20	-	3.1	3.1	3.1	-	-
21	-	3.1	3.1	3.1	-	-
25	3.7	-	3.7	3.8	0.14	3.7
25	-	3.9	3.9	-	-	-
30	4.8	-	4.8	4.8	-	-
35	-	6.9	6.9	5.9	1.41	23.9
35	4.9	-	4.9	-	-	-
40	-	9.9	9.9	9.0	2.71	30.1
40	-	11.2	11.2	-	-	-
40	6.0	-	6.0	-	-	-
45	-	13.7	13.7	14.6	1.27	8.7
45	-	15.5	15.5	-	-	-
50	23.3	-	23.3	29.2	8.27	28.3
50	-	35.0	35.0	-	-	-
55	44.6	-	44.6	44.6	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Y = 0.1447*X+0.1442	0.992	Reactor-A
Y = 0.2496*X -0.8458	0.901	Reactor-B
Y = 0.2031*X -0.3678	0.832	Combined Data
Y = 0.1909*X -0.3077	0.920	Average Data
Post-Induction Period (40-55 hr):		
Y = 2.4529*X -93.92	0.939	Reactor-A
Y = 2.2114*X -80.24	0.813	Reactor-B
Y = 2.2648*X -83.43	0.892	Combined Data
Y = 2.4280*X -90.98	0.964	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 31. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "F"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$					
	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	-	0.4	0.4	1.2	1.06	88.3
0	-	1.9	1.9	-	-	-
5	1.3	-	1.3	1.4	0.12	8.6
5	-	1.3	1.3	-	-	-
5	-	1.5	1.5	-	-	-
10	2.0	-	2.0	2.2	0.47	21.4
10	1.8	-	1.8	-	-	-
10	-	2.7	2.7	-	-	-
15	2.4	-	2.4	2.6	0.28	10.8
15	-	2.8	2.8	-	-	-
20	-	3.4	3.4	3.4	-	-
25	-	4.1	4.1	4.2	0.07	1.7
25	-	4.2	4.2	-	-	-
30	4.4	-	4.4	4.8	0.57	11.9
30	-	5.2	5.2	-	-	-
35	6.8	-	6.8	6.8	1.00	14.7
35	5.8	-	5.8	-	-	-
35	-	7.8	7.8	-	-	-
40	9.1	-	9.1	11.4	3.25	28.5
40	-	13.7	13.7	-	-	-
45	-	19.4	19.4	19.4	-	-
50	-	43.9	43.9	43.6	0.49	1.1
50	-	43.2	43.2	-	-	-
55	-	58.3	58.3	58.3	-	-

TABLE 31. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "F" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-40 hr):		
Y = 0.1635*X +0.2300	0.949	Reactor-A
Y = 0.1615*X +0.6474	0.885	Reactor-B
Y = 0.1574*X +0.6106	0.899	Combined Data
Y = 0.1500*X +0.7000	0.944	Average Data
Post-Induction Period (40-55 hr):		
Y = 3.1885*X -117.3	0.955	Reactor-B
Y = 3.1561*X -114.7	0.994	Combined Data
Y = 3.2980*X -123.5	0.969	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 32. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "G"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	-	0.3	0.3	0.8	0.71	88.8
0	-	1.3	1.3	-	-	-
5	1.5	-	1.5	1.6	0.14	8.8
5	-	1.7	1.7	-	-	-
10	-	2.8	2.8	2.8	-	-
15	1.6	-	1.6	2.5	1.20	48.1
15	-	3.3	3.3	-	-	-
20	2.2	-	2.2	3.3	1.48	44.9
20	-	4.3	4.3	-	-	-
25	4.5	-	4.5	5.0	0.64	12.8
25	-	5.4	5.4	-	-	-
30	5.7	-	5.7	5.7	-	-
35	7.6	-	7.6	10.8	2.95	27.3
35	-	11.4	11.4	-	-	-
35	-	13.4	13.4	-	-	-
40	10.4	-	10.4	18.0	10.68	59.3
40	-	25.5	25.5	-	-	-
45	-	31.3	31.3	31.3	-	-
50	-	52.8	52.8	52.8	-	-
55	49.5	-	49.5	54.9	7.61	13.9
55	51.6	-	51.6	-	-	-
55	-	63.6	63.6	-	-	-

TABLE 32. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "G" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-35 hr):		
Y = 0.1622*X +0.065	0.846	Reactor-A
Y = 0.1646*X +1.076	0.983	Reactor-B
Y = 0.1540*X +0.702	0.804	Combined Data
Y = 0.1571*X +0.743	0.939	Average Data
Post-Induction Period (35-55 hr):		
Y = 2.3031*X -76.75	0.976	Reactor-A
Y = 2.5635*X -78.08	0.978	Reactor-B
Y = 2.3287*X -71.92	0.913	Combined Data
Y = 2.4600*X -77.14	0.951	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 33. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "H"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.5	-	0.5	0.4	0.21	52.5
0	-	0.2	0.2	-	-	-
5	1.2	-	1.2	1.2	0.06	5.0
5	1.2	-	1.2	-	-	-
5	-	1.3	1.3	-	-	-
10	1.5	-	1.5	1.5	-	-
15	2.0	-	2.0	2.5	0.71	28.4
15	-	3.0	3.0	-	-	-
20	2.5	-	2.5	2.8	0.42	15.0
20	-	3.1	3.1	-	-	-
25	2.8	-	2.8	3.1	0.35	11.3
25	-	3.3	3.3	-	-	-
30	3.7	-	3.7	3.9	0.28	7.2
30	-	4.1	4.1	-	-	-
35	4.5	-	4.5	4.8	0.42	8.8
35	5.1	-	5.1	-	-	-
40	6.5	-	6.5	8.1	1.44	17.8
40	-	8.5	8.5	-	-	-
40	-	9.3	9.3	-	-	-
45	7.4	-	7.4	11.1	3.42	30.8
45	9.3	-	9.3	-	-	-
45	-	12.8	12.8	-	-	-
45	-	15.0	15.0	-	-	-
50	10.8	-	10.8	14.1	3.46	24.5
50	13.7	-	13.7	-	-	-
50	-	17.7	17.7	-	-	-
55	46.5	-	46.8	47.3	7.98	16.9
55	-	39.8	39.8	-	-	-
55	-	55.7	55.7	-	-	-
60	-	63.4	63.4	63.4	-	-

TABLE 33. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "H" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-48 hr):		
Y = 0.1303*X +0.2585	0.933	Reactor-A
Y = 0.2027*X -0.3333	0.879	Reactor-B
Y = 0.1646*X -0.0376	0.829	Combined Data
Y = 0.1567*X +0.0111	0.868	Average Data
Post-Induction Period (48-60 hr):		
Y = 6.8500*X -330.3	0.995	Reactor-A
Y = 4.5700*X -207.2	0.854	Reactor-B
Y = 5.3683*X -252.2	0.903	Combined Data
Y = 4.9300*X -229.5	0.961	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 34. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "I"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.3	-	0.3	0.9	0.78	86.7
0	-	1.4	1.4	-	-	-
4	1.2	-	1.2	1.2	-	-
5	1.4	-	1.4	1.7	0.42	24.7
5	-	2.0	2.0	-	-	-
9	2.0	-	2.0	2.0	-	-
10	-	3.2	3.2	3.2	-	-
15	3.2	-	3.2	3.5	0.36	10.3
15	-	3.9	3.9	-	-	-
15	-	3.4	3.4	-	-	-
20	4.1	-	4.1	4.6	0.50	10.9
20	4.5	-	4.5	-	-	-
20	-	5.1	5.1	-	-	-
25	7.9	-	7.9	8.1	0.53	6.5
25	-	8.7	8.7	-	-	-
25	-	7.7	7.7	-	-	-
29	9.2	-	9.2	9.2	-	-
30	11.1	-	11.1	14.4	3.30	22.9
30	-	17.7	17.7	-	-	-
30	-	14.3	14.3	-	-	-
35	19.1	-	19.1	23.0	8.95	38.9
35	16.6	-	16.6	-	-	-
35	-	33.2	33.2	-	-	-
40	31.6	-	31.6	38.5	9.69	25.2
40	-	45.3	45.3	-	-	-
45	48.5	-	48.5	55.0	5.63	10.2
45	-	58.1	58.1	-	-	-
45	-	58.4	58.4	-	-	-
50	58.3	-	58.3	64.0	4.95	7.7
50	-	67.2	67.2	-	-	-
50	-	66.5	66.5	-	-	-

TABLE 34. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "I" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-30 hr):		
Y = 0.2889*X -0.3210	0.915	Reactor-A
Y = 0.2704*X +0.5383	0.884	Reactor-B
Y = 0.2818*X +0.0596	0.891	Combined Data
Y = 0.2887*X -0.0007	0.927	Average Data
Post-Induction Period (30-50 hr):		
Y = 2.4459*X -64.48	0.978	Reactor-A
Y = 2.5601*X -58.92	0.987	Reactor-B
Y = 2.6368*X -66.53	0.930	Combined Data
Y = 2.6479*X -67.05	0.991	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 35. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "J"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	1.3	1.13	86.9
0	-	2.0	2.0	-	-	-
0	-	1.9	1.9	-	-	-
5	1.1	-	1.1	1.2	0.42	35.0
5	0.9	-	0.9	-	-	-
5	-	1.7	1.7	-	-	-
10	2.3	-	2.3	2.2	0.21	9.6
10	2.0	-	2.0	-	-	-
15	2.6	-	2.6	3.6	1.41	39.2
15	-	4.6	4.6	-	-	-
20	4.5	-	4.5	5.4	0.83	15.4
20	-	6.1	6.1	-	-	-
20	-	5.7	5.7	-	-	-
25	6.8	-	6.8	8.1	1.14	14.1
25	-	8.4	8.4	-	-	-
25	-	9.0	9.0	-	-	-
30	10.2	-	10.2	11.6	1.91	16.5
30	-	12.9	12.9	-	-	-
35	15.5	-	15.5	15.9	0.49	3.1
35	16.2	-	16.2	-	-	-
40	35.1	-	35.1	39.1	5.59	14.3
40	-	43.0	43.0	-	-	-
45	44.1	-	44.1	54.5	8.98	16.5
45	-	59.8	59.8	-	-	-
45	-	59.5	59.5	-	-	-
50	58.5	-	58.5	59.6	1.56	2.6
50	-	60.7	60.7	-	-	-

TABLE 35. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "J" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-35 hr):		
Y = 0.4431*X -2.0081	0.904	Reactor-A
Y = 0.3149*X +0.9120	0.879	Reactor-B
Y = 0.3898*X -0.7115	0.868	Combined Data
Y = 0.4136*X -1.0750	0.901	Average Data
Post-Induction Period (35-50 hours):		
Y = 2.8094*X -81.31	0.985	Reactor-A
Y = 1.7700*X -23.90	0.720	Reactor-B
Y = 2.9759*X -83.70	0.856	Combined Data
Y = 2.9300*X -82.25	0.929	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 36. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "L"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.9	0.81	90.0
0	-	1.0	1.0	-	-	-
0	-	0.5	0.5	-	-	-
0	-	1.9	1.9	-	-	-
5	-	0.8	0.8	0.8	-	-
10	2.1	-	2.1	2.4	0.42	17.5
10	2.3	-	2.3	-	-	-
10	-	2.9	2.9	-	-	-
15	3.1	-	3.1	3.4	0.42	12.4
15	2.8	-	2.8	-	-	-
15	3.4	-	3.4	-	-	-
15	-	3.7	3.7	-	-	-
15	-	3.3	3.3	-	-	-
15	-	3.4	3.4	-	-	-
15	-	4.1	4.1	-	-	-
20	4.1	-	4.1	4.9	0.61	12.5
20	5.7	-	5.7	-	-	-
20	-	5.3	5.3	-	-	-
20	-	4.9	4.9	-	-	-
20	-	4.7	4.7	-	-	-
25	8.4	-	8.4	7.7	0.99	12.9
25	-	6.6	6.6	-	-	-
25	-	8.2	8.2	-	-	-
30	-	11.6	11.6	13.5	2.62	19.4
30	-	15.3	15.3	-	-	-
35	20.4	-	20.4	23.1	3.82	16.5
35	-	25.8	25.8	-	-	-
40	42.3	-	42.3	46.9	3.54	7.6
40	-	49.3	49.3	-	-	-
40	-	50.2	50.2	-	-	-
40	-	43.9	43.9	-	-	-
40	-	48.7	48.7	-	-	-
45	53.5	-	53.5	58.6	4.08	7.0
45	-	60.4	60.4	-	-	-
45	-	57.4	57.4	-	-	-
45	-	63.0	63.0	-	-	-
50	58.7	-	58.7	61.8	2.72	4.4
50	-	63.5	63.5	-	-	-
50	-	63.3	63.3	-	-	-

TABLE 36. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "L" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-29 hours):		
Y = 0.3049*X -0.8592	0.862	Reactor-A
Y = 0.2335*X +0.5785	0.880	Reactor-B
Y = 0.2523*X +0.1625	0.849	Combined Data
Y = 0.2703*X -0.0286	0.920	Average Data
Post-Induction Period (29-45 hours):		
Y = 3.3100*X -93.67	0.966	Reactor-A
Y = 3.2124*X -82.72	0.971	Reactor-B
Y = 3.1792*X -83.05	0.940	Combined Data
Y = 3.1820*X -83.80	0.973	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 37. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "M"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.5	-	0.5	1.3	1.06	81.5
0	-	2.0	2.0	-	-	-
5	1.4	-	1.4	1.4	0.00	0.0
5	-	1.4	1.4	-	-	-
10	2.9	-	2.9	2.7	0.28	10.4
10	-	2.5	2.5	-	-	-
15	3.1	-	3.1	3.3	0.40	1.2
15	-	3.1	3.1	-	-	-
15	-	3.8	3.8	-	-	-
20	4.3	-	4.3	4.4	0.07	1.6
20	-	4.5	4.5	-	-	-
25	6.0	-	6.0	5.7	0.49	8.6
25	-	5.3	5.3	-	-	-
30	-	7.8	7.8	7.8	-	-
35	14.9	-	14.9	18.6	5.23	28.1
35	-	22.3	22.3	-	-	-
40	35.6	-	35.6	36.3	0.92	2.5
40	-	36.9	36.9	-	-	-
45	50.5	-	50.5	51.2	0.92	1.8
45	-	51.8	51.8	-	-	-
50	59.0	-	59.0	59.4	0.57	1.0
50	-	59.8	59.8	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-30 hours):		
Y = 0.2080*X +0.4333	0.970	Reactor-A
Y = 0.1943*X +0.8857	0.883	Reactor-B
Y = 0.2015*X +0.6643	0.915	Combined Data
Y = 0.2129*X +0.6071	0.948	Average Data
Post-Induction Period (30-50 hours):		
Y = 2.9440*X -85.20	0.967	Reactor-A
Y = 2.6700*X -71.08	0.990	Reactor-B
Y = 2.7239*X -74.36	0.975	Combined Data
Y = 2.7160*X -73.98	0.987	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 38. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "N"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.6	-	0.6	1.0	0.64	64.0
0	0.6	-	0.6	-	-	-
0	-	1.7	1.7	-	-	-
5	2.1	-	2.1	1.7	0.35	20.6
5	1.6	-	1.6	-	-	-
5	1.3	-	1.3	-	-	-
5	-	1.9	1.9	-	-	-
10	2.3	-	2.3	2.6	0.67	25.8
10	2.2	-	2.2	-	-	-
10	-	3.4	3.4	-	-	
15	3.4	-	3.4	3.6	0.18	5.0
15	-	3.7	3.7	-	-	-
15	-	3.8	3.8	-	-	-
15	-	3.5	3.5	-	-	-
20	6.2	-	6.2	5.3	0.78	14.7
20	-	4.8	4.8	-	-	-
20	-	4.9	4.9	-	-	-
25	6.2	-	6.2	6.2	0.00	0.0
25	-	6.2	6.2	-	-	-
30	8.5	-	8.5	7.4	2.14	28.9
30	9.3	-	9.3	-	-	-
30	-	8.8	8.8	-	-	-
35	14.0	-	14.0	15.7	1.70	10.8
35	-	15.7	15.7	-	-	-
35	-	17.4	17.4	-	-	-
40	33.8	-	33.8	37.1	2.40	6.5
40	-	36.7	36.7	-	-	-
40	-	38.7	38.7	-	-	-
40	-	39.0	39.0	-	-	-
45	54.1	-	54.1	56.4	2.25	4.0
45	-	56.4	56.4	-	-	-
45	-	58.6	58.6	-	-	-
50	59.3	-	59.3	59.4	0.07	0.1
50	-	59.4	59.4	-	-	-

TABLE 38. Oxidation of Fuel No. 18496 at 100°C Containing 17 mg/L of Antioxidant "N" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-33 hours):		
Y = 0.2735*X +0.1592	0.959	Reactor-A
Y = 0.2210*X +0.8450	0.904	Reactor-B
Y = 0.2544*X +0.3700	0.936	Combined Data
Y = 0.2207*X +0.6607	0.989	Average Data
Post-Induction Period (33-50 hours):		
Y = 4.0100*X -126.4	1.000	Reactor-A
Y = 4.0950*X -126.3	0.995	Reactor-B
Y = 4.0667*X -126.2	0.986	Combined Data
Y = 4.0700*X -126.4	0.999	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 39. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "A"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.6	-	0.6	1.4	0.67	47.9
0	1.7	-	1.7	-	-	-
0	-	1.8	1.8	-	-	-
5	0.7	-	0.7	1.5	0.52	34.7
5	1.6	-	1.6	-	-	-
5	1.9	-	1.9	-	-	-
5	-	1.6	1.6	-	-	-
10	1.3	-	1.3	2.0	0.92	46.0
10	-	2.6	2.6	-	-	-
15	-	1.9	1.9	1.9	-	-
25	1.5	-	1.5	1.7	0.21	12.4
25	-	1.8	1.8	-	-	-
30	2.2	-	2.2	2.0	0.29	14.5
30	2.2	-	2.2	-	-	-
30	-	1.7	1.7	-	-	-
35	2.5	-	2.5	2.3	0.35	15.2
35	-	2.0	2.0	-	-	-
40	-	2.1	2.1	2.1	-	-
50	3.3	-	3.3	3.3	0.07	2.1
50	-	3.2	3.2	-	-	-
55	3.2	-	3.2	3.2	0.07	2.2
55	-	3.1	3.1	-	-	-
60	-	2.9	2.9	2.9	-	-
65	-	3.1	3.1	3.1	-	-
70	3.3	-	3.3	3.3	-	-
75	4.5	-	4.5	4.0	0.70	17.5
75	3.2	-	3.2	-	-	-
75	-	4.3	4.3	-	-	-
80	4.5	-	4.5	4.5	0.00	0.0
80	-	4.5	4.5	-	-	-
85	-	3.9	3.9	3.9	-	-
90	-	4.2	4.2	4.2	-	-
95	4.8	-	4.8	4.8	-	-
100	7.1	-	7.1	7.1	--	
110	-	13.6	13.6	17.5	5.52	31.5
110	-	21.4	21.4	-	-	-
115	-	22.4	22.4	24.8	3.39	13.7
115	-	27.2	27.2	-	-	-
120	27.5	-	27.5	27.5	-	-
125	44.4	-	44.4	38.6	8.20	21.2
125	32.8	-	32.8	-		--
130	49.3	-	49.3	43.9	7.64	17.4
130	-	38.5	38.5	-	-	-
135	-	45.7	45.7	-	-	-

(GEF5.C)

TABLE 39. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "A" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-95 hours):		
Y = 0.0380*X +1.0881	0.886	Reactor-A
Y = 0.0307*X +1.4126	0.801	Reactor-B
Y = 0.0348*X +1.2179	0.848	Combined Data
Y = 0.0338*X +1.2328	0.913	Average Data
Post-Induction Period (95-135 hours):		
Y = 1.2217*X -113.9	0.929	Reactor-A
Y = 1.0742*X -99.9	0.933	Reactor-B
Y = 1.1500*X -107.2	0.913	Combined Data
Y = 1.1125*X -103.1	0.982	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 40. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "B"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.3	-	0.3	1.2	1.20	100.0
0	2.0	-	2.0	-	-	-
5	0.6	-	0.6	0.8	0.21	26.2
5	-	0.9	0.9	-	-	-
10	-	0.5	0.5	0.5	-	-
56	2.6	-	2.6	2.6	-	-
60	1.8	-	1.8	1.8	-	-
65	2.8	-	2.8	2.8	0.07	2.5
65	-	2.7	2.7	-	-	-
70	3.4	-	3.4	3.2	0.35	10.9
70	-	2.9	2.9	-	-	-
75	2.8	-	2.8	2.8	-	-
80	2.4	-	2.4	2.6	0.28	10.8
80	2.8	-	2.8	-	-	-
85	3.2	-	3.2	3.2	-	-
90	4.5	3.7	4.5	4.1	0.57	13.9
90	-	-	3.7	-	-	-
95	2.7	-	2.7	4.0	1.21	30.3
95	5.1	-	5.1	-	-	-
95	-	4.2	4.2	-	-	-
100	3.0	-	3.0	3.0	-	-
105	5.4	-	5.4	5.4	-	-
110	7.1	-	7.1	7.1	-	-
115	14.9	-	14.9	12.4	3.54	28.6
115	-	9.9	9.9	-	-	-
120	-	20.7	20.7	20.7	-	-
125	16.9	-	16.9	16.9	-	-
130	27.8	-	27.8	27.8	-	-
135	31.5	-	31.5	31.5	-	-
145	34.4	-	34.4	34.4	-	-
150	37.4	-	37.4	37.4	-	-

TABLE 40. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "B" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-100 hours):		
Y = 0.0281*X +0.8743	0.619	Reactor-A
Y = 0.0376*X +0.3865	0.976	Reactor-B
Y = 0.0310*X +0.7085	0.727	Combined Data
Y = 0.0298*X +0.6949	0.825	Average Data
Post-Induction Period (100-150 hours):		
Y = 0.7380*X -71.60	0.963	Reactor-A
Y = 0.7441*X -72.32	0.949	Combined Data
Y = 0.7412*X -71.88	0.956	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 41. Oxidation of Fuel No. 18497 of 100°C Containing 17 mg/L of Antioxidant "C"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.3	-	0.3	0.5	0.28	56.0
0	-	0.7	0.7	-	-	-
5	1.2	-	1.2	1.6	0.58	36.3
5	1.0	-	1.0	-	-	-
5	-	1.7	1.7	-	-	-
5	-	2.3	2.3	-	-	-
10	0.4	-	0.4	1.1	0.99	90.0
10	-	1.8	1.8	1.8	-	-
20	-	1.1	1.1	1.1	-	-
30	-	1.6	1.6	1.6	-	-
35	1.4	-	1.4	1.4	-	-
55	1.6	-	1.6	1.6	-	-
60	2.3	-	2.3	2.7	0.49	18.2
60	-	3.0	3.0	-	-	-
65	-	2.5	2.5	2.5	-	-
70	2.5	-	2.5	2.5	-	-
75	2.7	-	2.7	2.8	0.14	5.0
75	-	2.9	2.9	-	-	-
80	-	3.3	3.3	3.6	0.35	9.7
80	-	3.8	3.8	-	-	-
81	-	2.9	2.9	2.9	-	-
85	3.1	-	3.1	3.4	0.31	9.1
85	-	3.3	3.3	-	-	-
85	-	3.7	3.7	-	-	-
90	-	2.5	2.5	2.5	-	-
95	-	2.5	2.5	2.5	-	-
100	2.8	-	2.8	3.2	0.57	17.8
100	-	3.6	3.6	-	-	-
105	4.1	-	4.1	5.2	1.85	35.6
105	-	4.3	4.3	-	-	-
105	-	7.4	7.4	-	-	-
110	-	5.6	5.6	5.6	-	-
120	-	13.0	13.0	13.0	-	-
125	-	21.4	21.4	21.4	-	-
131	-	29.4	29.4	29.4	-	-
135	-	33.0	33.0	33.0	-	-
145	-	37.5	37.5	37.5	-	-
150	-	42.2	42.2	42.2	-	-
155	-	47.5	47.5	47.5	-	-
160	-	51.3	51.3	51.3	-	-

TABLE 41. Oxidation of Fuel No. 18497 of 100°C Containing 17 mg/L of Antioxidant "C" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-105 hr):		
Y = 0.0265*X +0.5827	0.870	Reactor-A
Y = 0.0287*X +1.2552	0.545	Reactor-B
Y = 0.0298*X +0.8162	0.637	Combined Data
Y = 0.0267*X +0.8690	0.706	Average Data
Post-Induction Period (105-160 hr):		
Y = 0.8612*X -86.22	0.982	Reactor-B
Y = 0.8815*X -89.15	0.983	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 42. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "D"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average
0	0.0	-	0.0	0.0
5	-	0.3	0.3	0.3
10	-	0.0	0.0	0.0
15	0.0	-	0.0	0.0
20	1.0	-	1.0	1.0
40	1.0	-	1.0	1.0
45	1.3	-	1.3	1.3
55	-	2.8	2.8	2.8
60	-	2.7	2.7	2.7
65	2.1	-	2.1	2.1
70	2.2	-	2.2	2.2
80	-	3.8	3.8	3.8
85	-	4.4	4.4	4.4
90	4.4	-	4.4	4.4
95	7.5	-	7.5	7.5
105	-	26.2	26.2	26.2
110	19.8	-	19.8	25.9
110	-	31.9	31.9	-
115	27.5	-	27.5	27.5
125	-	42.3	42.3	42.3
130	-	40.7	40.7	40.7
131	45.3	45.3	45.3	45.3
135	41.0	-	41.0	41.0
140	46.0	-	46.0	46.0

Linear Regression of the Data

Equations	R^2	Source
Induction Period (0-90 hours):		
Y = 0.0436*X -0.3794	0.876	Reactor-A
Y = 0.0523*X -0.2391	0.983	Reactor-B
Y = 0.0486*X -0.3643	0.900	Combined Data
Y = 0.0486*X -0.3643	0.900	Average Data
Post-Induction Period (90-140 hours):		
Y = 0.8795*X -75.17	0.976	Reactor-A
Y = 0.6439*X -40.11	0.936	Reactor-B
Y = 0.8438*X -68.41	0.901	Combined Data
Y = 0.8478*X -69.02	0.933	Average Data

Notes:

R^2 = Coefficient of determination.

TABLE 43. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "E"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	-	1.9	1.9	1.9	-
5	-	1.4	1.4	1.4	-
25	-	1.7	1.7	1.7	-
30	-	1.7	1.7	1.7	-
40	2.6	-	2.6	2.6	-
45	1.9	-	1.9	1.9	-
50	2.6	-	2.6	2.4	0.28
50	-	2.2	2.2	-	-
55	2.9	-	2.9	2.7	0.35
55	-	2.4	2.4	-	-
60	-	4.8	4.8	4.8	-
65	-	4.2	4.2	3.4	1.20
65	2.5	-	2.5	-	-
70	2.8	-	2.8	2.8	-
75	3.8	-	3.8	4.0	0.21
75	-	4.1	4.1	-	-
80	4.0	-	4.0	4.1	0.07
80	-	4.1	4.1	-	-
85	-	5.8	5.8	5.8	-
90	3.6	-	3.6	4.9	1.84
90	-	6.2	6.2	-	-
95	3.9	-	3.9	5.0	1.56
95	-	6.1	6.1	-	-
100	-	6.9	6.9	6.9	-
101	5.7	-	5.7	5.7	-
105	5.4	-	5.4	5.4	-
110	5.0	-	5.0	5.0	-
115	8.0	-	8.0	8.0	-
120	18.2	-	18.2	18.2	-
125	24.8	-	24.8	24.8	-
135	32.0	-	32.0	32.0	-
140	35.1	-	35.1	35.1	-
145	40.6	-	40.6	40.6	-
150	46.9	-	46.9	46.9	-

TABLE 43. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "E" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-110 hours):		
Y = 0.0455*X +0.1617	0.811	Reactor-A
Y = 0.0539*X +0.6854	0.824	Reactor-B
Y = 0.0454*X +0.6915	0.702	Combined Data
Y = 0.0449*X +0.8148	0.788	Average Data
Post-Induction Period (110-150 hours):		
Y = 1.0213*X -106.40	0.981	Reactor-A

Notes:

St. Dev. = Standard deviation of all data.
R^2 = Coefficient of determination.

TABLE 44. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "F"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.7	-	1.7	1.2	0.71	59.1
0	0.7	-	0.7	-	-	-
5	1.5	-	1.5	1.4	0.21	15.0
5	1.2	-	1.2	-	-	-
10	-	2.2	2.2	2.2	-	-
15	-	1.7	1.7	1.7	-	-
55	-	3.0	3.0	3.0	-	-
60	-	2.4	2.4	2.5	0.14	5.6
60	-	2.6	2.6	-	-	-
65	3.4	-	3.4	3.1	0.49	15.8
65	-	2.7	2.7	-	-	-
70	3.2	-	3.2	3.2	-	-
75	3.5	-	3.5	3.4	0.21	6.2
75	3.2	-	3.2	-	-	-
80	3.8	-	3.8	3.4	0.40	11.8
80	3.4	-	3.4	-	-	-
80	-	3.0	3.0	-	-	-
85	-	3.0	3.0	3.1	0.17	5.5
85	-	3.3	3.3	-	-	-
85	-	3.0	3.0	-	-	-
90	4.4	-	4.4	3.8	0.53	14.0
90	-	3.6	3.6	-	-	-
90	-	3.4	3.4	-	-	-
95	4.7	-	4.7	4.7	0.07	1.5
95	4.6	-	4.6	-	-	-
96	5.7	-	5.7	5.7	-	-
100	5.9	-	5.9	5.1	0.92	18.0
100	5.3	-	5.3	-	-	-
100	-	4.1	4.1	-	-	-
105	6.2	-	6.2	5.0	1.04	20.8
105	-	4.3	4.3	-	-	-
105	-	4.5	4.5	-	-	-
110	-	4.9	4.9	4.8	0.14	2.9
110	-	4.7	4.7	-	-	-
115	18.3	-	18.3	9.4	7.75	82.5
115	-	4.4	4.4	-	-	-
115	-	5.4	5.4	-	-	-
120	30.6	-	30.6	27.6	2.57	9.3
120	26.3	-	26.3	-	-	-
120	26.0	-	26.0	-	-	-
125	32.6	-	32.6	26.3	11.00	41.8
125	32.7	-	32.7	-	-	-
125	-	13.6	13.6	-	-	-
130	-	21.6	21.6	21.7	0.07	0.3
130	-	21.7	21.7	-	-	-

TABLE 44. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "F" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
135	-	26.9	26.9	26.9	-	-
140	40.0	-	40.0	40.0	-	-
145	45.0	-	45.0	46.0	1.34	2.9
145	46.9	-	46.9	-	-	-
150	51.6	-	51.6	44.7	9.83	22.0
150	-	37.7	37.7	-	-	-
155	-	41.9	41.9	41.9	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period:		
Y = 0.0407*X +0.9505	0.878	Reactor-A (0-105 hours)
Y = 0.0295*X +1.0912	0.799	Reactor-B (0-115 hours)
Y = 0.0339*X +1.0490	0.770	Combined Data (0-105 hours)
Y = 0.0329*X +1.1658	0.822	Average Data (0-105 hours)
Post-Induction Period:		
Y = 0.8764*X -79.60	0.973	Reactor-A (95-150 hours)
Y = 0.9328*X -101.4	0.985	Reactor-B (115-155 hours)
Y = 0.7996*X -76.50	0.826	Combined Data (100-155 hours)
Y = 0.7646*X -71.86	0.896	Average Data (100-155 hours)

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 45. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "G"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	1.3	-	1.3	1.3	-
5	1.8	-	1.8	2.7	1.27
5	-	3.6	3.6	-	-
10	-	2.0	2.0	-	-
15	-	2.0	2.0	2.0	-
65	4.9	-	4.9	4.9	-
70	5.1	-	5.1	5.1	-
75	5.3	-	5.3	5.8	0.64
75	-	6.2	6.2	-	-
80	6.5	-	6.5	6.5	0.07
80	-	6.4	6.4	-	-
85	9.7	-	9.7	7.6	2.97
85	-	5.5	5.5	-	-
90	15.1	-	15.1	10.8	6.08
90	-	6.5	6.5	-	-
96	25.8	-	25.8	25.8	-
97	-	20.0	20.0	20.0	-
100	30.4	-	30.4	28.0	3.39
100	-	25.6	25.6	-	-
105	-	32.9	32.9	32.9	-
110	35.9	-	35.9	32.4	5.02
110	-	28.8	28.8	-	-
115	43.4	-	43.4	39.1	6.08
115	-	34.8	34.8	-	-
120	44.3	-	44.3	43.9	0.64
120	-	43.4	43.4	-	-
125	49.3	-	49.3	49.2	0.14
125	-	49.1	49.1	-	-
130	-	47.3	47.3	47.3	-
135	-	49.2	49.2	49.2	-

TABLE 45. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "G" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-80 hours):		
Y = 0.0566*X +1.3658	0.974	Reactor-A
Y = 0.0538*X +2.0488	0.854	Reactor-B
Y = 0.0600*X +1.3000	0.975	Combined Data
Y = 0.0548*X +1.6142	0.943	Average Data
Post-Induction Period (80-135 hours):		
Y = 0.9751*X -70.85	0.978	Reactor-A
Y = 0.9057*X -68.39	0.945	Reactor-B
Y = 0.9083*X -66.67	0.934	Combined Data
Y = 0.8621*X -61.84	0.946	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 46. Oxidation of Fuel No. 18496 of 100°C Containing 17 mg/L of Antioxidant "H"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.3	-	1.3	1.3	-	-
5	1.4	-	1.4	1.4	-	-
15	-	2.4	2.4	2.4	-	-
21	1.8	-	1.8	1.8	-	-
25	1.9	-	1.9	1.9	-	-
30	1.4	-	1.4	1.4	-	-
35	1.2	-	1.2	1.7	0.64	37.7
35	-	2.4	2.4	-	-	-
35	-	1.4	1.4	-	-	-
40	-	2.3	2.3	1.9	0.64	33.7
40	-	1.4	1.4	-	-	-
45	2.0	-	2.0	2.0	-	-
50	2.1	-	2.1	2.1	0.1	4.8
50	2.2	-	2.2	-	-	-
50	-	2.0	2.0	-	-	-
55	2.2	-	2.2	2.1	0.14	6.7
55	-	-	2.0	-	-	-
60	2.2	-	2.2	2.4	0.36	15.0
60	2.0	-	2.0	-	-	-
60	-	2.8	2.8	-	-	-
60	-	2.1	2.1	-	-	-
60	-	2.7	2.7	-	-	-
65	1.9	-	1.9	2.5	0.78	31.2
65	-	3.4	3.4	-	-	-
65	-	2.3	2.3	-	-	-
70	2.8	-	2.8	2.9	0.07	2.4
70	2.9	-	2.9	-	-	-
75	3.5	-	3.5	3.0	0.56	18.7
75	3.1	-	3.1	-	-	-
75	-	2.4	2.4	-	-	-
80	3.4	-	3.4	3.0	0.40	13.3
80	-	2.6	2.6	-	-	-
80	-	3.0	3.0	-	-	-
85	3.7	-	3.7	3.1	0.53	17.1
85	2.6	-	2.6	-	-	-
85	-	3.7	3.7	-	-	-
85	-	2.7	2.7	-	-	-
85	-	3.0	3.0	-	-	-
90	2.8	-	2.8	3.4	0.87	25.6
90	-	4.4	4.4	-	-	-
90	-	3.0	3.0	-	-	-
95	6.2	-	6.2	5.6	0.85	15.2
95	5.0	-	5.0	-	-	-
100	5.5	-	5.5	4.6	1.03	22.4
100	4.9	-	4.9	-	-	-
100	-	3.5	3.5	-	-	-

TABLE 46. Oxidation of Fuel No. 18496 of 100°C Containing 17 mg/L of Antioxidant "H" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
105	4.1	-	4.1	4.2	0.50	11.9
105	-	3.7	3.7	-	-	-
105	-	4.7	4.7	-	-	-
110	5.2	-	5.2	4.9	0.89	18.2
110	-	3.9	3.9	-	-	-
110	-	5.6	5.6	-	-	-
115	6.8	-	6.8	5.3	2.12	40.0
115	-	3.8	3.8	-	-	-
125	-	11.1	11.1	11.1	-	-
130	-	13.3	13.3	13.3	-	-
130	-	25.6	25.6	25.6	-	-
135	27.7	-	27.7	27.9	0.21	0.8
135	-	28.0	28.0	-	-	-
140	32.3	-	32.3	32.3	-	-
145	-	31.4	31.4	31.4	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-115 hours):		
Y = 0.0422*X +0.2850	0.728	Reactor-A
Y = 0.0292*X +0.8442	0.628	Reactor-B
Y = 0.0362*X +0.5137	0.662	Combined Data
Y = 0.0332*X +0.8440	0.799	Average Data
Post-Induction Period (114-145 hours):		
Y = 1.0271*X -111.3	0.999	Reactor-A
Y = 0.9970*X -110.7	0.823	Reactor-B
Y = 1.0094*X -111.2	0.869	Combined Data
Y = 1.0050*X -111.1	0.835	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 47. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "I"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average
0	1.5	-	1.5	1.5
5	-	-	-	-
15	2.9	-	2.9	2.9
20	2.7	-	2.7	2.7
25	-	-	-	-
30	-	-	-	-
35	-	-	-	-
40	4.8	-	4.8	4.8
44	5.4	-	5.4	5.4
45	5.6	-	5.6	5.6
50	-	-	-	-
55	-	-	-	-
60	-	7.5	7.5	7.5
65	13.6	-	13.6	13.6
70	15.4	-	15.4	15.4
75	-	-	-	-
80	-	-	-	-
85	-	31.0	31.0	31.0
90	37.7	-	37.7	37.5
90	?	37.2	37.2	-
95	42.8	-	42.8	42.8
100	-	-	-	-
110	-	49.0	49.0	49.0

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-60 hours):		
Y = 0.0899*X +1.3588	0.976	Reactor-A
Y = 0.0979*X +1.2101	0.975	Reactors A&B
Y = 0.0979*X +1.2101	0.975	Average
Post-Induction Period (60-95 hours):		
Y = 1.0169*X -53.98	0.992	Reactor-A
Y = 0.9739*X -51.05	0.998	Reactor-B
Y = 0.9990*X -52.75	0.994	Reactors A&B
Y = 0.9961*X -52.57	0.993	Average

Notes:

R^2 = Coefficient of determination.

TABLE 48. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "J"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	0.6	-	0.6	0.6	-
5	1.5	-	1.5	1.9	0.57
5	-	2.3	2.3	-	-
10	2.2	-	2.2	2.2	-
15	-	2.3	2.3	2.3	-
16	2.6	-	2.6	2.6	-
20	2.8	-	2.8	3.1	0.35
20	-	3.3	3.3	-	-
26	-	4.2	4.2	4.2	-
30	3.4	-	3.4	3.9	0.71
30	-	4.4	4.4	-	-
35	3.7	-	3.7	3.7	-
40	3.9	-	3.9	4.2	0.42
40	-	4.5	4.5	-	-
45	5.5	-	5.5	5.3	0.28
45	-	5.1	5.1	-	-
50	-	8.2	8.2	8.2	-
55	6.0	-	6.0	6.8	1.06
55	-	7.5	7.5	-	-
60	9.0	-	9.0	9.6	0.85
60	-	10.2	10.2	-	-
65	-	11.6	11.6	11.6	-
70	-	16.1	16.1	16.1	-
76	-	28.0	28.0	28.0	-
80	25.8	-	25.8	29.2	4.81
80	-	32.6	32.6	-	-
85	30.1	-	30.1	30.1	-
86	-	34.7	34.7	34.7	-
90	-	39.1	39.1	39.1	-
100	41.3	-	41.3	41.3	-
105	44.2	-	44.2	44.2	-
110	-	46.8	46.8	46.8	-

TABLE 48. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "J" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-55 hrs):		
Y = 0.0892*X +0.9368	0.952	Reactor-A
Y = 0.0961*X +1.3641	0.891	Reactor-B
Y = 0.0941*X +1.0847	0.896	Reactors A&B
Y = 0.0953*X +1.0415	0.932	Average
Post-Induction Period (55-110 hrs):		
Y = 0.7829*X -37.21	0.998	Reactor-A
Y = 0.8077*X -36.92	0.933	Reactor-B
Y = 0.7888*X -36.36	0.955	Reactors A&B
Y = 0.7788*X -35.61	0.956	Average

Notes:

St. Dev. = Standard deviation of all data.
R^2 = Coefficient of determination.

TABLE 49. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "L"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	0.0	-	0.0	0.0	-
5	0.5	-	0.5	0.5	-
10	-	1.2	1.2	1.2	-
15	-	1.2	1.2	1.2	-
25	1.7	-	1.7	1.7	-
30	2.5	-	2.5	2.5	-
35	-	2.5	2.5	2.5	-
40	-	3.8	3.8	4.2	0.49
40	-	4.5	4.5	-	-
45	-	4.6	4.6	4.6	-
50	5.0	-	5.0	5.1	0.14
50	5.2	-	5.2	-	-
55	7.1	-	7.1	6.6	0.71
55	6.1	-	6.1	-	-
60	-	8.6	8.6	8.6	-
65	-	10.0	10.0	10.1	0.07
65	-	10.1	10.1	-	-
70	-	14.3	14.3	14.3	-
75	24.5	-	24.5	24.7	0.28
75	24.9	-	24.9	-	-
80	29.7	-	29.7	29.7	-
85	-	29.8	29.8	29.8	-
90	-	34.5	34.5	34.5	-
96	40.5	-	40.5	40.5	-
100	45.5	-	45.5	45.5	-
106	-	44.5	44.5	44.5	-

TABLE 49. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "L" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-55 hours):		
Y = 0.1169*X -0.4323	0.9463	Reactor-A
Y = 0.1005*X -0.1335	0.8893	Reactor-B
Y = 0.1135*X -0.4107	0.9303	Combined Data
Y = 0.1088*X -0.3294	0.9339	Average Data
Post-Induction Period (55-105 hours):		
Y = 0.8498*X -39.60	0.9958	Reactor-A
Y = 0.8512*X -44.10	0.9873	Reactor-B
Y = 0.8474*X -41.61	0.9665	Combined Data
Y = 0.8481*X -41.75	0.9685	Average Data

Notes:

St. Dev. = Standard deviation of all data.
R^2 = Coefficient of determination.

TABLE 50. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "M"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	1.3	-	1.3	1.3	-
5	1.6	-	1.6	1.6	-
10	-	1.7	1.7	1.7	-
15	-	1.7	1.7	1.7	-
25	2.4	-	2.4	2.4	-
30	2.7	-	2.7	2.7	-
35	-	2.6	2.6	2.6	-
40	-	3.8	3.8	3.9	0.07
40	-	3.9	3.9	-	-
45	4.5	-	4.5	4.3	0.28
45	-	4.1	4.1	-	-
50	4.2	-	4.2	4.5	0.42
50	4.8	-	4.8	-	-
55	4.7	-	4.7	4.7	-
60	-	4.1	4.1	4.1	-
65	-	4.9	4.9	5.8	1.27
65	-	6.7	6.7	-	-
70	-	10.3	10.3	10.3	-
75	18.4	-	18.4	18.4	-
80	26.8	-	26.8	26.8	-
85	-	23.7	23.7	23.7	-
90	-	27.6	27.6	31.3	5.16
90	-	34.9	34.9	-	-
95	42.1	-	42.1	41.3	1.20
95	40.4	-	40.4	-	-
100	46.1	-	46.1	46.1	-

TABLE 50. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "M" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-65 hours):		
Y = 0.0662*X +1.1238	0.9508	Reactor-A
Y = 0.0719*X +0.7253	0.8271	Reactor-B
Y = 0.0680*X +0.9716	0.8766	Combined Data
Y = 0.0646*X +1.0153	0.9168	Average Data
Post-Induction Period (65-100 hours):		
Y = 1.0709*X -60.55	0.9884	Reactor-A
Y = 0.9990*X -59.40	0.9573	Reactor-B
Y = 1.1256*X -67.49	0.9559	Combined Data
Y = 1.1255*X -67.39	0.9623	Average Data

Notes:

St. Dev. = Standard deviation of all data.
R^2 = Coefficient of determination.

TABLE 51. Oxidation of Fuel No. 18497 at 100°C Containing 17 mg/L of Antioxidant "N"

Stress	(Peroxides, ppm)$^{1/2}$			
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average
0	1.7	-	1.7	1.7
5	1.8	-	1.8	1.8
10	-	2.7	2.7	2.7
15	-	2.6	2.6	2.6
25	3.2	-	3.2	3.2
30	3.3	-	3.3	3.3
35	-	3.9	3.9	3.9
40	-	4.3	4.3	4.3
45	5.0	-	5.0	5.0
50	5.7	-	5.7	5.5
50	5.2	-	5.2	-
50	-	5.7	5.7	-
55	-	5.8	5.8	5.8
60	-	10.3	10.3	10.3
66	15.4	-	15.4	15.4
70	21.4	-	21.4	21.4
71	-	22.1	22.1	22.1
75	26.1	-	26.1	27.3
75	-	28.5	28.5	-
80	33.2	-	33.2	33.2
85	-	38.5	38.5	38.5
90	-	44.6	44.6	44.6
96	46.5	-	46.5	46.5
100	50.7	-	50.7	50.7

Linear Regression Analysis of the Data

Equation	R^2	Source
Induction Period (0-55 hours):		
Y = 0.0776*X +1.4279	0.9698	Reactor-A
Y = 0.0744*X +1.6242	0.9525	Reactor-B
Y = 0.0752*X +1.5171	0.9606	Combined Data
Y = 0.0740*X +1.5339	0.9660	Average Data
Post-Induction Period (55-100 hours):		
Y = 1.0037*X -49.25	0.9920	Reactor-A
Y = 1.1193*X -56.37	0.9978	Reactor-B
Y = 1.0392*X -51.34	0.9891	Combined Data
Y = 1.0399*X -51.45	0.9906	Average Data

Notes:

R^2 = Coefficient of determination.

TABLE 52. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "A"

Stress Time, hr	(Peroxides)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.
0	1.0	-	1.0	0.5	0.71
0	-	0.0	0.0	-	-
1	1.0	-	1.0	0.8	0.28
1	-	0.6	0.6	-	-
2	1.8	-	1.8	1.7	0.21
2	-	1.5	1.5	-	-
3	2.4	-	2.4	2.3	0.21
3	-	2.1	2.1	-	-
4	3.0	-	3.0	2.9	0.14
4	-	2.8	2.8	-	-
5	3.8	-	3.8	3.7	0.14
5	-	3.6	3.6	-	-
6	4.7	-	4 7	4.5	0.21
6	4.2	-	4.2	-	-
6	-	4.5	4.5	-	-
6	-	4.4	4.4	-	-
7	5.6	-	5.6	5.5	0.13
7	5.3	-	5.3	-	-
7	-	5.5	5.5	-	-
7	-	5.5	5.5	-	-
8	8.5	-	8.5	7.6	0.70
8	6.8	-	6.8	-	-
8	-	7.6	7.6	-	-
8	-	7.5	7.5	-	-
9	14.6	-	14.6	12.8	1.63
9	10.7	-	10.7	-	-
9	-	13.3	13.3	-	-
9	-	12.5	12.5	-	-
10	20.9	-	20.9	23.0	2.9
10	-	25.0	25.0	-	-
11	34.1	-	34.1	36.9	3.96
11	-	39.7	39.7	-	-
12	44.9	-	44.9	48.4	4.88
12	-	51.8	51.8	-	-
13	51.8	-	51.8	55.4	5.02
13	-	58.9	58.9	-	-

TABLE 52. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "A" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-8 hours):		
Y = 0.80760*X +0.17224	0.904	Reactor-A
Y = 0.89605*X -0.45623	0.962	Reactor-B
Y = 0.85182*X -0.14200	0.931	Combined Data
Y = 0.82500*X -0.02222	0.956	Average Data
Post-Induction Period (8-13 hours):		
Y = 9.3083*X -69.046	0.980	Reactor-A
Y = 11.000*X -82.963	0.984	Reactor-B
Y = 10.154*X -76.004	0.968	Combined Data
Y = 10.277*X -77.227	0.986	Average Data

Notes:

St. Dev. = Standard deviation of all data.
R^2 = Coefficient of determination.

TABLE 53. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "B"

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.2	0.21	105.0
0	-	0.3	0.3	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.4	0.49	122.5
2	-	0.7	0.7	-	-	-
3	1.8	-	1.8	2.1	0.35	16.7
3	-	2.3	2.3	-	-	-
4	3.3	-	3.3	3.5	0.21	6.0
4	-	3.6	3.6	-	-	-
5	4.9	-	4.9	5.1	0.28	5.5
5	-	5.3	5.3	-	-	-
6	6.6	-	6.6	6.9	0.32	4.6
6	7.0	-	7.0	-	-	-
6	-	7.3	7.3	-	-	-
6	-	6.7	6.7	-	-	-
7	9.6	-	9.6	11.5	1.31	11.4
7	12.7	-	12.7	-	-	-
7	-	11.8	11.8	-	-	-
7	-	11.7	11.7	-	-	-
8	19.3	-	19.3	22.3	2.53	11.3
8	23.7	-	23.7	-	-	-
8	-	25.0	25.0	-	-	-
8	-	-	21.3	-	-	-
9	35.1	-	35.1	39.2	3.63	9.3
9	40.7	-	40.7	-	-	-
9	-	43.4	43.4	-	-	-
9	-	-	37.5	-	-	-
10	50.3	-	50.3	51.8	2.05	4.0
10	-	53.2	53.2	-	-	-
11	56.7	-	56.7	59.3	3.68	6.2
11	-	61.9	61.9	-	-	-
12	60.3	-	60.3	64.2	5.44	8.5
12	-	68.0	68.0	-	-	-

TABLE 53. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "B" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.2557*X -1.2882	0.926	Reactor-A
Y = 1.2481*X -0.9373	0.942	Reactor-B
Y = 1.2519*X -1.1127	0.931	Combined Data
Y = 1.1929*X -0.9786	0.923	Average Data
Post-Induction Period (6-11 hours):		
Y = 10.877*X -61.931	0.961	Reactor-A
Y = 11.788*X -67.502	0.968	Reactor-B
Y = 11.332*X -64.717	0.961	Combined Data
Y = 11.423*X -65.261	0.979	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 54. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "C"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	1.8	-	1.8	1.8	0.00	0.0
2	-	1.8	1.8	-	-	-
3	2.9	-	2.9	3.0	0.07	2.3
3	-	3.0	3.0	-	-	-
4	4.2	-	4.2	4.2	0.07	1.7
4	-	4.1	4.1	-	-	-
5	5.9	-	5.9	5.9	0.07	1.2
5	-	5.8	5.8	-	-	-
6	10.1	-	10.1	10.1	0.00	0.0
6	-	10.1	10.1	-	-	-
7	16.8	-	16.8	16.6	0.28	1.7
7	-	16.4	16.4	-	-	-
8	31.9	-	31.9	30.8	1.63	5.3
8	-	29.6	29.6	-	-	-
9	49.5	-	49.5	49.3	0.28	0.6
9	-	49.1	49.1	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.5893*X -1.2107	0.912	Reactor-A
Y = 1.5786*X -1.1929	0.908	Reactor-B
Y = 1.5839*X -1.2018	0.910	Combined Data
Y = 1.5893*X -1.1964	0.914	Average Data
Post-Induction Period (6-9 hours):		
Y = 13.330*X -72.900	0.966	Reactor-A
Y = 13.020*X -71.350	0.951	Reactor-B
Y = 13.175*X -72.125	0.958	Combined Data
Y = 13.180*X -72.150	0.960	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 55. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "D"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.2	0.21	105.0
1	-	0.3	0.3	-	-	-
2	1.9	-	1.9	1.9	0.00	0.0
2	-	1.9	1.9	-	-	-
3	3.2	-	3.2	3.3	0.14	4.2
3	-	3.4	3.4	-	-	-
4	4.5	-	4.5	4.7	0.21	4.5
4	-	4.8	4.8	-	-	-
5	6.7	-	6.7	6.7	0.07	1.0
5	-	6.6	6.6	-	-	-
6	11.1	-	11.1	10.9	0.28	2.6
6	-	10.7	10.7	-	-	-
7	21.4	-	21.4	20.9	0.78	3.7
7	-	20.3	20.3	-	-	-
8	37.8	-	37.8	37.2	0.92	2.5
8	-	36.5	36.5	-	-	-
9	51.4	-	51.4	52.5	1.48	2.8
9	-	53.5	53.5	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-5 hours):		
Y = 1.3800*X -0.73333	0.960	Reactor-A
Y = 1.3714*X -0.59524	0.977	Reactor-B
Y = 1.3757*X -0.66429	0.968	Combined Data
Y = 1.3829*X -0.65714	0.971	Average Data
Post-Induction Period (6-9 hours):		
Y = 13.730*X -72.550	0.993	Reactor-A
Y = 14.460*X -78.200	0.986	Reactor-B
Y = 14.095*X -75.375	0.988	Combined Data
Y = 14.110*X -75.450	0.990	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 56. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "E"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	1.4	-	1.4	1.4	0.00	0.0
2	-	1.4	1.4	-	-	-
3	2.8	-	2.8	2.7	0.07	2.6
3	-	2.6	2.6	-	-	-
4	3.8	-	3.8	3.9	0.14	3.6
4	3.9	-	3.9	-	-	-
4	-	4.0	4.0	-	-	-
4	-	4.0	4.0	-	-	-
5	5.3	-	5.3	5.6	0.10	1.8
5	5.7	-	5.7	-	-	-
5	-	5.7	5.7	-	-	-
5	-	5.7	5.7	-	-	-
6	7.8	-	7.8	7.9	0.20	2.5
6	7.8	-	7.8	-	-	-
6	-	8.0	8.0	-	-	-
6	-	7.8	7.8	-	-	-
7	13.4	-	13.4	13.7	0.10	0.7
7	13.5	-	13.5	-	-	-
7	-	13.8	13.8	-	-	-
7	-	14.1	14.1	-	-	-
8	25.6	-	25.6	26.3	0.32	1.2
8	26.2	-	26.2	-	-	-
8	-	26.2	26.2	-	-	-
8	-	27.2	27.2	-	-	-
9	42.9	-	42.9	42.9	0.94	2.2
9	41.8	-	41.8	-	-	-
9	-	42.9	42.9	-	-	-
9	-	44.1	44.1	-	-	-
10	59.4	-	59.4	59.0	0.64	1.1
10	-	58.5	58.5	-	-	-
11	67.8	-	67.8	69.3	2.05	3.0
11	-	70.7	70.7	-	-	-

TABLE 56. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "E" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.3542*X -1.0250	0.968	Reactor-A
Y = 1.3875*X -1.0750	0.962	Reactor-B
Y = 1.3708*X -1.0500	0.960	Combined Data
Y = 1.3357*X -0.9357	0.957	Average Data
Post-Induction Period (7-11 hours):		
Y = 14.297*X -86.989	0.992	Reactor-A
Y = 14.577*X -88.543	0.997	Reactor-B
Y = 14.437*X -87.766	0.994	Combined Data
Y = 14.390*X -87.270	0.994	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 57. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "F"

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	1.0	-	1.0	0.9	0.00	0.0
2	-	0.7	0.7	-	-	-
3	2.5	-	2.5	2.5	0.07	2.8
3	-	2.4	2.4	-	-	-
4	3.7	-	3.7	3.8	0.07	1.8
4	-	3.8	3.8	-	-	-
5	5.5	-	5.5	5.8	0.35	6.0
5	6.1	-	6.1	-	-	-
5	-	5.5	5.5	-	-	-
5	-	6.1	6.1	-	-	-
6	7.6	-	7.6	8.3	0.79	9.5
6	8.8	-	8.8	-	-	-
6	-	7.6	7.6	-	-	-
6	-	9.1	9.1	-	-	-
7	13.2	-	13.2	15.8	2.52	15.9
7	18.2	-	18.2	-	-	-
7	-	14.1	14.1	-	-	-
7	-	17.7	17.7	-	-	-
8	26.0	-	26.0	28.6	2.55	8.9
8	31.1	-	31.1	-	-	-
8	-	26.8	26.8	-	-	-
8	-	30.4	30.4	-	-	-
9	47.6	-	47.6	48.0	0.49	1.0
9	-	48.3	48.3	-	-	-
10	59.0	-	59.0	59.3	0.35	0.6
10	-	59.5	59.5	-	-	-

TABLE 57. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "F" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.4532*X -1.2558	0.939	Reactor-A
Y = 1.4872*X -1.3767	0.929	Reactor-B
Y = 1.4702*X -1.3163	0.934	Combined Data
Y = 1.4071*X -1.1786	0.936	Average Data
Post-Induction Period (6-10 hours):		
Y = 13.024*X -72.873	0.965	Reactor-A
Y = 13.129*X -73.420	0.968	Reactor-B
Y = 13.077*X -73.146	0.966	Combined Data
Y = 13.420*X -75.360	0.980	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 58. Oxidation at 120°C of Fuel No. 18496 Containing 17 mg/L of Antioxidant "G"

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	1.2	-	1.2	1.1	0.21	19.1
1	-	0.9	0.9	-	-	-
2	2.2	-	2.2	2.1	0.14	6.7
2	-	2.0	2.0	-	-	-
3	3.3	-	3.3	3.3	0.07	2.1
3	-	3.2	3.2	-	-	-
4	4.7	-	4.7	5.3	0.85	16.0
4	5.9	-	5.9	-	-	-
4	-	4.5	4.5	-	-	-
4	-	6.2	6.2	-	-	-
5	6.7	-	6.7	7.3	0.94	12.9
5	8.0	-	8.0	-	-	-
5	-	6.3	6.3	-	-	-
5	-	8.2	8.2	-	-	-
6	10.2	-	10.2	11.5	2.16	18.8
6	13.0	-	13.0	-	-	-
6	-	9.4	9.4	-	-	-
6	-	13.9	13.9	-	-	-
7	23.1	-	23.1	23.3	1.28	5.5
7	22.3	-	22.3	-	-	-
7	-	22.5	22.5	-	-	-
7	-	25.1	25.1	-	-	-
8	37.6	-	37.6	38.4	2.14	5.6
8	37.3	-	37.3	-	-	-
8	-	37.1	37.1	-	-	-
8	-	41.6	41.6	-	-	-
9	47.7	-	47.7	50.5	2.61	5.2
9	50.3	-	50.3	-	-	-
9	-	49.9	49.9	-	-	-
9	-	54.0	54.0	-	-	-
10	53.3	-	53.3	57.3	3.54	6.2
10	58.6	-	58.6	-	-	-
10	-	55.8	55.8	-	-	-
10	-	61.5	61.5	-	-	-

TABLE 58. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "G" (Cont'd)

<u>Linear Regression Analysis of the Data</u>

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.8719*X -1.2187	0.889	Reactor-A
Y = 1.9021*X -1.3875	0.846	Reactor-B
Y = 1.8870*X -1.3031	0.867	Combined Data
Y = 1.7893*X -0.9964	0.930	Average Data
Post-Induction Period (6-10 hours):		
Y = 11.500*X -56.660	0.980	Reactor-A
Y = 12.220*X -60.640	0.970	Reactor-B
Y = 11.860*X -58.650	0.971	Combined Data
Y = 11.880*X -58.840	0.986	Average Data

<u>Notes</u>:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 59. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "H"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.6	-	1.6	1.1	0.50	45.5
0	0.6	-	0.6	-	-	-
0	-	1.0	1.0	-	-	-
1	1.5	-	1.5	1.6	0.14	8.8
1	-	1.7	1.7	-	-	-
2	2.0	-	2.0	2.2	0.28	12.7
2	-	2.4	2.4	-	-	-
3	2.9	-	2.9	3.2	0.35	10.9
3	-	3.4	3.4	-	-	-
4	4.0	-	4.0	4.0	0.21	5.3
4	3.7	-	3.7	-	-	-
4	-	4.0	4.0	-	-	-
4	-	4.2	4.2	-	-	-
5	5.5	-	5.5	5.2	0.33	6.4
5	5.2	-	5.2	-	-	-
5	4.9	-	4.9	-	-	-
5	-	4.9	4.9	-	-	-
5	-	5.1	5.1	-	-	-
5	-	5.7	5.7	-	-	-
6	8.5	-	8.5	7.6	0.66	8.7
6	7.3	-	7.3	-	-	-
6	7.1	-	7.1	-	-	-
6	-	7.1	7.1	-	-	-
6	-	7.2	7.2	-	-	-
6	-	8.4	8.4	-	-	-
7	12.5	-	12.5	12.2	0.64	5.3
7	-	11.5	11.5	-	-	-
7	-	12.7	12.7	-	-	-
8	22.8	-	22.8	21.7	1.73	8.0
8	-	22.6	19.7	-	-	-
8	-	22.6	22.6	-	-	-
9	39.1	-	39.1	39.2	0.07	0.2
9	-	39.2	39.2	-	-	-
10	49.4	-	49.4	51.9	3.54	6.8
10	-	54.4	54.4	-	-	-

TABLE 59. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "H" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.05417*X +0.40417	0.893	Reactor-A
Y = 1.07737*X +0.37198	0.912	Reactor-B
Y = 1.06519*X +0.39089	0.902	Combined Data
Y = 1.01786*X +0.50357	0.933	Average Data
Post-Induction Period (7-10 hours):		
Y = 12.6999*X -76.9999	0.991	Reactor-A
Y = 14.2122*X -89.3829	0.974	Reactor-B
Y = 13.5562*X -84.1264	0.978	Combined Data
Y = 13.6600*X -84.8600	0.989	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 60. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "I"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.1	0.21	19.1
0	-	1.2	1.2	-	-	-
1	2.1	-	2.1	2.1	0.00	0.0
1	-	2.1	2.1	-	-	-
2	3.4	-	3.4	3.4	0.07	2.1
2	-	3.3	3.3	-	-	-
3	5.3	-	5.3	5.3	0.00	0.0
3	-	5.3	5.3	-	-	-
4	8.4	-	8.4	8.5	0.07	0.8
4	-	8.5	8.5	-	-	-
5	15.2	-	15.2	15.5	0.35	2.3
5	-	15.7	15.7	-	-	-
6	26.5	-	26.5	27.3	1.13	4.1
6	-	28.1	28.1	-	-	-
7	44.6	-	44.6	45.9	1.84	4.0
7	-	47.2	47.2	-	-	-
8	58.5	-	58.5	59.5	1.41	2.4
8	-	60.5	60.5	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-4 hours):		
Y = 1.8200*X +0.3800	0.957	Reactor-A
Y = 1.7800*X +0.5200	0.936	Reactor-B
Y = 1.8000*X +0.4500	0.946	Combined Data
Y = 1.8000*X +0.4800	0.945	Average Data
Post-Induction Period (5-8 hours):		
Y = 14.800*X -60.00	0.993	Reactor-A
Y = 15.350*X -61.90	0.993	Reactor-B
Y = 15.080*X -60.95	0.990	Combined Data
Y = 15.060*X -60.84	0.993	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 61. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "J"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.0	-	1.0	1.5	0.71	47.3
0	-	2.0	2.0	-	-	-
1	2.2	-	2.2	2.1	0.14	6.7
1	-	2.0	2.0	-	-	-
2	3.4	-	3.4	3.3	0.14	4.2
2	-	3.2	3.2	-	-	-
3	5.3	-	5.3	5.2	0.21	4.0
3	-	5.0	5.0	-	-	-
4	8.0	-	8.0	8.0	0.07	0.9
4	-	7.9	7.9	-	-	-
5	13.5	-	13.5	13.7	0.21	1.5
5	-	13.8	13.8	-	-	-
6	20.8	-	20.8	22.1	1.84	8.3
6	-	23.4	23.4		-	-
7	38.5	-	38.5	38.5	0.00	0.0
7	-	38.5	38.5	-	-	-
8	53.6	-	53.6	54.2	0.78	1.4
8	-	54.7	54.7	-	-	-
9	67.3	-	67.3	67.4	0.14	0.2
9	-	67.5	67.5	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-4 hours):		
Y = 1.71000*X +0.5600	0.965	Reactor-A
Y = 1.48000*X +1.0600	0.882	Reactor-B
Y = 1.59500*X +0.8100	0.923	Combined Data
Y = 1.61000*X +0.8000	0.933	Average Data
Post-Induction Period (5-9 hours):		
Y = 14.04*X -59.54	0.988	Reactor-A
Y = 13.87*X -57.51	0.994	Reactor-B
Y = 13.96*X -58.53	0.990	Combined Data
Y = 13.95*X -58.47	0.991	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 62. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "L"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.1	0.28	25.5
0	-	1.3	1.3	-	-	-
1	1.8	-	1.8	1.8	0.07	3.9
1	-	1.7	1.7	-	-	-
2	2.9	-	2.9	2.8	0.14	5.0
2	-	2.7	2.7	-	-	-
3	4.3	-	4.3	4.3	0.07	1.6
3	-	4.2	4.2	-	-	-
4	6.5	-	6.5	6.6	0.07	1.1
4	-	6.6	6.6	-	-	-
5	11.4	-	11.4	11.2	0.28	2.5
5	-	11.0	11.0	-	-	-
6	19.5	-	19.5	19.3	0.35	1.8
6	-	19.0	19.0	-	-	-
7	34.4	-	34.4	33.9	0.71	2.1
7	-	33.4	33.4	-	-	-
8	50.7	-	50.7	51.0	0.35	0.7
8	-	51.2	51.2	-	-	-
9	64.5	-	64.5	64.3	0.28	0.4
9	-	64.1	64.1	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-9 hours):		
Y = 1.3700*X +0.5400	0.967	Reactor-A
Y = 1.3100*X +0.6800	0.922	Reactor-B
Y = 1.3400*X +0.6100	0.944	Combined Data
Y = 1.3500*X +0.6200	0.948	Average Data
Post-Induction Period (5-9 hours):		
Y = 13.74*X -60.08	0.989	Reactor-A
Y = 13.84*X -61.14	0.987	Reactor-B
Y = 13.79*X -60.61	0.988	Combined Data
Y = 13.79*X -60.59	0.988	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 63. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "M"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.2	-	1.2	1.5	0.35	23.3
0	-	1.7	1.7	-	-	-
1	2.0	-	2.0	2.0	0.00	0.0
1	-	2.0	2.0	-	-	-
2	3.0	-	3.0	3.0	0.07	2.3
2	-	2.9	2.9	-	-	-
3	4.5	-	4.5	4.4	0.21	4.8
3	-	4.2	4.2	-	-	-
4	6.5	-	6.5	6.4	0.21	3.3
4	-	6.2	6.2	-	-	-
5	9.9	-	9.9	9.7	0.28	2.9
5	-	9.5	9.5	-	-	-
6	20.1	-	20.1	19.5	0.85	4.4
6	-	18.9	18.9	-	-	-
7	36.3	-	36.3	35.0	1.91	5.5
7	-	33.6	33.6	-	-	-
8	55.0	-	55.0	53.9	1.56	2.9
8	-	52.8	52.8	-	-	-
9	62.7	-	62.7	64.4	2.40	3.7
9	-	66.1	66.1	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-5 hours):		
Y = 1.6714*X +0.3381	0.930	Reactor-A
Y = 1.5114*X +0.6381	0.897	Reactor-B
Y = 1.5914*X +0.4881	0.912	Combined Data
Y = 1.5886*X +0.5286	0.917	Average Data
Post-Induction Period (5-9 hours):		
Y = 14.05*X -61.55	0.985	Reactor-A
Y = 14.71*X -66.79	0.989	Reactor-B
Y = 14.38*X -64.17	0.986	Combined Data
Y = 14.38*X -64.16	0.989	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 64. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "N"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.2	-	1.2	1.3	0.07	5.0
0	-	1.3	1.3	-	-	-
1	2.1	-	2.1	2.1	0.07	3.3
1	-	2.0	2.0	-	-	-
2	3.1	-	3.1	3.3	0.36	10.9
2	3.2	-	3.2	-	-	-
2	-	3.0	3.0	-	-	-
2	-	3.8	3.8	-	-	-
3	4.6	-	4.6	4.6	0.22	4.8
3	4.5	-	4.5	-	-	-
3	-	4.4	4.4	-	-	-
3	-	4.9	4.9	-	-	-
4	6.5	-	6.5	6.8	0.39	5.7
4	6.7	-	6.7	-	-	-
4	-	6.7	6.7	-	-	-
4	-	7.4	7.4	-	-	-
5	11.4	-	11.4	11.6	0.83	7.1
5	10.7	-	10.7	-	-	-
5	11.5	-	11.5	-	-	-
5	-	11.0	11.0	-	-	-
5	-	12.1	12.1	-	-	-
5	-	13.0	13.0	-	-	-
6	17.2	-	17.2	19.3	3.14	16.3
6	19.8	-	19.8	-	-	-
6	-	16.6	16.6	-	-	-
6	-	23.5	23.5	-	-	-
7	30.6	-	30.6	34.9	4.14	11.9
7	34.7	-	34.7	-	-	-
7	-	33.7	33.7	-	-	-
7	-	40.5	40.5	-	-	-
8	48.4	-	48.4	52.1	3.73	7.2
8	50.2	-	50.2	-	-	-
8	-	52.7	52.7	-	-	-
8	-	57.0	57.0	-	-	-
9	58.7	-	58.7	63.3	6.43	10.2
9	-	67.8	67.8	-	-	-

TABLE 64. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "N" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-5 hours):		
Y = 1.37207*X +0.72883	0.966	Reactor-A
Y = 1.46577*X +0.70631	0.935	Reactor-B
Y = 1.41892*X +0.71757	0.946	Combined Data
Y = 1.35000*X +0.92000	0.966	Average Data
Post-Induction Period (5-9 hours):		
Y = 12.45*X -52.85	0.978	Reactor-A
Y = 14.36*X -61.96	0.970	Reactor-B
Y = 13.40*X -57.41	0.960	Combined Data
Y = 13.62*X -59.10	0.987	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 65. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "A"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.4	-	0.4	0.2	0.28	140.0
3	-	0.0	0.0	-	-	-
4	0.5	-	0.5	0.6	0.14	23.3
4	-	0.7	0.7	-	-	-
5	0.7	-	0.7	0.6	0.14	23.3
5	-	0.5	0.5	-	-	-
6	1.0	-	1.0	0.9	0.21	23.3
6	1.1	-	1.1	-	-	-
6	-	0.7	0.7	-	-	-
7	1.7	-	1.7	1.2	0.51	42.5
7	1.3	-	1.3	-	-	-
7	-	0.5	0.5	-	-	-
7	-	1.4	1.4	-	-	-
8	1.9	-	1.9	1.7	0.15	8.8
8	1.6	-	1.6	-	-	-
8	-	1.8	1.8	-	-	-
8	-	1.6	1.6	-	-	-
9	1.8	-	1.8	2.0	0.13	6.5
9	2.1	-	2.1	-	-	-
9	-	2.0	2.0	-	-	-
9	-	1.9	1.9	-	-	-
10	2.5	-	2.5	2.5	0.00	0.0
10	-	2.5	2.5	-	-	-
11	2.8	-	2.8	2.8	0.07	2.5
11	-	2.7	2.7	-	-	-
12	3.0	-	3.0	3.6	0.59	16.4
12	3.4	-	3.4	-	-	-
12	-	3.5	3.5	-	-	-
12	-	4.4	4.4	-	-	-
13	3.2	-	3.2	3.4	0.73	21.5
13	2.7	-	2.7	-	-	-
13	-	3.1	3.1	-	-	-
13	-	4.4	4.4	-	-	-

TABLE 65. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "A" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
14	3.7	-	3.7	4.2	0.83	19.8
14	4.1	-	4.1	-	-	-
14	-	3.6	3.6	-	-	-
14	-	5.4	5.4	-	-	-
15	4.1	-	4.1	4.7	0.70	14.9
15	5.2	-	5.2	-	-	-
15	-	4.0	4.0	-	-	-
15	-	5.3	5.3	-	-	-
16	5.2	-	5.2	5.7	0.71	12.5
16	-	6.2	6.2	-	-	-
17	5.9	-	5.9	5.6	1.28	22.9
17	4.2	-	4.2	-	-	-
17	-	6.7	6.7	-	-	-
18	7.6	-	7.6	8.2	0.53	6.5
18	8.6	-	8.6	-	-	-
18	-	8.4	8.4	-	-	-
19	13.7	-	13.7	15.1	1.29	8.5
19	16.2	-	16.2	-	-	-
19	-	15.5	15.5	-	-	-
20	20.5	-	20.5	23.0	2.15	9.3
20	24.4	-	24.4	-	-	-
20	-	24.0	24.0	-	-	-
21	29.2	-	29.2	31.5	2.08	6.6
21	33.2	-	33.2	-	-	-
21	-	32.2	32.2	-	-	-
22	40.5	-	40.5	44.4	5.44	12.3
22	-	48.2	48.2	-	-	-
23	46.1	-	46.1	49.5	4.81	9.7
23	-	52.9	52.9	-	-	-
24	49.9	-	49.9	52.2	3.25	6.2
24	-	54.9	54.9	-	-	-
25	54.0	-	54.0	55.6	2.19	3.9
25	-	57.1	57.1	-	-	-

TABLE 65. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "A" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-17 hours):		
Y = 0.32888*X -0.7198	0.931	Reactor-A
Y = 0.39668*X -1.1493	0.890	Reactor-B
Y = 0.36049*X -0.9200	0.897	Combined Data
Y = 0.35676*X -0.7268	0.956	Average Data
Post-Induction Period (17-23 hours):		
Y = 7.1684*X -119.54	0.974	Reactor-A
Y = 8.3893*X -140.94	0.963	Reactor-B
Y = 7.7387*X -129.68	0.956	Combined Data
Y = 7.8750*X -132.17	0.976	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 66. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "B"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	0.0	-	0.0	-	-	-
0	-	0.0	0.0	-	-	-
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.0	-	0.0	0.0	0.00	0.0
3	-	0.0	0.0	-	-	-
4	0.5	-	0.5	0.9	0.49	54.4
4	-	1.2	1.2	-	-	-
5	1.4	-	1.4	1.3	0.14	10.8
5	-	1.2	1.2	-	-	-
6	1.2	-	1.2	1.2	0.42	35.0
6	0.9	-	0.9	-	-	-
6	-	1.8	1.8	-	-	-
6	-	0.9	0.9	-	-	-
7	1.6	-	1.6	1.6	0.37	23.1
7	1.5	-	1.5	-	-	-
7	-	2.0	2.0	-	-	-
7	-	1.1	1.1	-	-	-
8	1.7	-	1.7	1.7	0.36	21.2
8	1.5	-	1.5	-	-	-
8	-	2.2	2.2	-	-	-
8	-	1.4	1.4	-	-	-
9	1.4	-	1.4	1.8	0.59	32.8
9	-	2.5	2.5	-	-	-
9	-	1.6	1.6	-	-	-
10	1.9	-	1.9	2.0	0.07	3.5
10	-	2.0	2.0	-	-	-
11	2.2	-	2.2	2.2	0.00	0.0
11	-	2.2	2.2	-	-	-
12	2.3	-	2.3	2.3	0.07	3.0
12	-	2.2	2.2	-	-	-
13	2.3	-	2.3	2.6	0.19	7.3
13	2.7	-	2.7	-	-	-
13	-	2.6	2.6	-	-	-
13	-	2.7	2.7	-	-	-

TABLE 66. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "B" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
14	2.9	-	2.9	2.9	0.08	2.8
14	2.8	-	2.8	-	-	-
14	-	2.9	2.9	-	-	-
14	-	3.0	3.0	-	-	-
15	3.4	-	3.4	3.3	0.22	6.7
15	3.2	-	3.2	-	-	-
15	-	3.0	3.0	-	-	-
15	-	3.5	3.5	-	-	-
16	4.0	-	4.0	4.0	0.07	1.8
16	-	3.9	3.9	-	-	-
17	4.0	-	4.0	4.1	0.14	3.4
17	-	4.2	4.2	-	-	-
18	4.5	-	4.5	4.4	0.36	8.2
18	4.2	-	4.2	-	-	-
18	-	4.9	4.9	-	-	-
18	-	4.1	4.1	-	-	-
19	5.4	-	5.4	5.0	0.43	8.6
19	4.7	-	4.7	-	-	-
19	-	5.4	5.4	-	-	-
19	-	4.6	4.6	-	-	-
20	5.8	-	5.8	5.7	0.35	6.1
20	5.3	-	5.3	-	-	-
20	-	6.1	6.1	-	-	-
20	-	5.5	5.5	-	-	-
21	8.6	-	8.6	9.1	0.97	10.7
21	8.4	-	8.4	-	-	-
21	-	10.5	10.5	-	-	-
21	-	8.7	8.7	-	-	-
22	12.4	-	12.4	14.3	2.14	15.0
22	13.0	-	13.0	-	-	-
22	-	17.2	17.2	-	-	-
22	-	14.6	14.6	-	-	-
23	21.6	-	21.6	22.2	0.78	3.5
23	-	22.7	22.7	-	-	-
24	30.5	-	30.5	31.2	0.99	3.2
24	-	31.9	31.9	-	-	-
25	39.8	-	39.8	40.2	0.49	1.2
25	-	40.5	40.5	-	-	-

TABLE 66. Oxidation of Fuel No. 18497 at 120 °C Containing 17 mg/L of Antioxidant "B" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-20 hours):		
Y = 0.2695*X -0.5044	0.950	Reactor-A
Y = 0.2687*X -0.3872	0.929	Reactor-B
Y = 0.2691*X -0.4445	0.938	Combined Data
Y = 0.2674*X -0.4359	0.961	Average Data
Post-Induction Period (20-25 hours):		
Y = 6.7833*X -133.08	0.951	Reactor-A
Y = 6.9000*X -134.28	0.975	Reactor-B
Y = 6.8417*X -133.68	0.960	Combined Data
Y = 7.0486*X -138.14	0.974	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 67. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "C"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.0	-	0.0	0.5	0.64	128.0
3	-	0.9	0.9	-	-	-
4	1.2	-	1.2	1.4	0.28	20.0
4	-	1.6	1.6	-	-	-
5	1.6	-	1.6	1.7	0.07	4.1
5	-	1.7	1.7	-	-	-
6	2.2	-	2.2	2.1	0.05	2.4
6	2.2	-	2.2	-	-	-
6	-	2.1	2.1	-	-	-
6	-	2.1	2.1	-	-	-
7	2.3	-	2.3	2.5	0.13	5.2
7	2.6	-	2.6	-	-	-
7	-	2.5	2.5	-	-	-
7	-	2.5	2.5	-	-	-
8	2.4	-	2.4	2.5	0.15	6.0
8	2.4	-	2.4	-	-	-
8	-	2.7	2.7	-	-	-
8	-	2.6	2.6	-	-	-
9	3.0	-	3.0	2.9	0.19	6.6
9	2.6	-	2.6	-	-	-
9	-	3.0	3.0	-	-	-
9	-	2.8	2.8	-	-	-
10	3.4	-	3.4	3.5	0.07	2.0
10	-	3.5	3.5	-	-	-
11	3.6	-	3.6	3.8	0.21	5.5
11	-	3.9	3.9	-	-	-
12	4.5	-	4.5	4.5	0.00	0.0
12	-	4.5	4.5	-	-	-
13	5.2	-	5.2	5.0	0.29	5.8
13	4.7	-	4.7	-	-	-
13	-	5.3	5.3	-	-	-
13	-	4.8	4.8	-	-	-
14	5.2	-	5.2	5.5	0.24	4.4
14	5.5	-	5.5	-	-	-
14	-	5.7	5.7	-	-	-
14	-	5.7	5.7	-	-	-

TABLE 67. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "C" (Cont'd)

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
15	7.6	-	7.6	7.8	0.19	2.4
15	7.6	-	7.6	-	-	-
15	-	7.8	7.8	-	-	-
15	-	8.0	8.0	-	-	-
16	14.0	-	14.0	15.0	1.41	9.4
16	-	16.0	16.0	-	-	-
17	23.4	-	23.4	24.2	1.06	4.4
17	-	24.9	24.9	-	-	-
18	32.3	-	32.3	33.3	1.41	4.2
18	-	34.3	34.3	-	-	-
19	40.8	-	40.8	42.5	2.40	3.3
19	-	44.2	44.2	-	-	-
20	46.5	-	46.5	49.3	3.89	7.9
20	-	52.0	52.0	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-14 hours):		
Y = 0.40856*X -0.55178	0.966	Reactor-A
Y = 0.41182*X -0.41496	0.977	Reactor-B
Y = 0.41043*X -0.48759	0.970	Combined Data
Y = 0.40464*X -0.43917	0.982	Average Data
Post-Induction Period (15-20 hours):		
Y = 8.0675*X -113.70	0.996	Reactor-A
Y = 8.9406*X -126.53	0.999	Reactor-B
Y = 8.5041*X -120.11	0.990	Combined Data
Y = 8.5457*X -120.87	0.998	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 68. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "D"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.9	-	0.9	0.9	0.00	0.0
3	-	0.9	0.9	-	-	-
4	1.8	-	1.8	1.6	0.35	21.9
4	-	1.3	1.3	-	-	-
5	1.7	-	1.7	1.8	0.07	3.9
5	-	1.8	1.8	-	-	-
6	2.3	-	2.3	1.9	0.33	17.4
6	1.6	-	1.6	-	-	-
6	-	2.1	2.1	-	-	-
6	-	1.7	1.7	-	-	-
7	2.8	-	2.8	2.4	0.39	16.3
7	2.0	-	2.0	-	-	-
7	-	2.6	2.6	-	-	-
7	-	2.1	2.1	-	-	-
8	2.4	-	2.4	2.4	0.00	0.0
8	-	2.4	2.4	-	-	-
9	2.7	-	2.7	2.8	0.14	5.0
9	-	2.9	2.9	-	-	-
10	3.4	-	3.4	3.4	0.07	2.1
10	-	3.3	3.3	-	-	-
11	3.7	-	3.7	3.7	0.07	1.9
11	-	3.6	3.6	-	-	-
12	4.2	-	4.2	4.0	0.26	6.5
12	3.8	-	3.8	-	-	-
12	-	4.2	4.2	-	-	-
12	-	3.7	3.7	-	-	-
13	5.1	-	5.1	4.9	0.24	4.9
13	4.7	-	4.7	-	-	-
13	-	5.0	5.0	-	-	-
13	-	4.6	4.6	-	-	-
14	6.0	-	6.0	6.0	0.13	2.2
14	6.0	-	6.0	-	-	-
14	-	5.9	5.9	-	-	-
14	-	6.2	6.2	-	-	-

TABLE 68. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "D" (Cont'd)

Stress	$(Peroxides, ppm)^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
15	10.2	-	10.2	8.9	1.21	13.6
15	8.9	-	8.9	-	-	-
15	-	9.3	9.3	-	-	-
15	-	7.3	7.3	-	-	-
16	16.3	-	16.3	15.8	0.71	4.5
16	-	15.3	15.3	-	-	-
17	25.5	-	25.2	25.1	0.57	2.3
17	-	24.7	24.7	-	-	-
18	34.3	-	34.3	33.8	0.71	2.1
18	-	33.3	33.3	-	-	-
19	42.0	-	42.0	41.9	0.14	0.3
19	-	41.8	41.8	-	-	-
20	48.1	-	48.1	48.0	0.21	0.4
20	-	47.8	47.8	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-14 hours):		
Y = 0.51289*X -0.9868	0.823	Reactor-A
Y = 0.48104*X -0.8661	0.874	Reactor-B
Y = 0.49696*X -0.9265	0.845	Combined Data
Y = 0.46868*X -0.7213	0.877	Average Data
Post-Induction Period (15-20 hours):		
Y = 7.9462*X -109.75	0.997	Reactor-A
Y = 8.1444*X -113.98	0.996	Reactor-B
Y = 8.0463*X -111.90	0.996	Combined Data
Y = 8.0714*X -112.33	0.997	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 69. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "E"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.5	-	0.5	0.5	0.07	14.0
3	-	0.4	0.4	-	-	-
4	0.8	-	0.8	0.8	0.00	0.0
4	-	0.8	0.8	-	-	-
5	1.0	-	1.0	1.2	0.28	23.3
5	-	1.4	1.4	-	-	-
6	1.5	-	1.5	1.5	0.00	0.0
6	-	1.5	1.5	-	-	-
7	2.0	-	2.0	1.6	0.34	21.3
7	1.5	-	1.5	-	-	-
7	-	1.7	1.7	-	-	-
7	-	1.2	1.2	-	-	-
8	2.1	-	2.1	2.2	0.07	3.2
8	1.5	-	1.5	-	-	-
8	-	2.2	2.2	-	-	-
8	-	1.6	1.6	-	-	-
9	2.3	-	2.3	2.2	0.22	10.0
9	2.4	-	2.4	-	-	-
9	-	2.2	2.2	-	-	-
9	-	1.9	1.9	-	-	-
10	2.5	-	2.5	2.7	0.21	7.8
10	-	2.8	2.8	-	-	-
11	2.8	-	2.8	2.7	0.14	5.2
11	-	2.6	2.6	-	-	-
12	3.0	-	3.0	3.0	0.07	2.3
12	-	2.9	2.9	-	-	-
13	3.0	-	3.0	3.0	0.00	0.0
13	-	3.0	3.0	-	-	-
14	3.4	-	3.4	3.6	0.20	5.6
14	-	3.8	3.8	-	-	-
14	-	3.6	3.6	-	-	-
15	3.8	-	3.8	3.8	0.08	2.1
15	3.9	-	3.9	-	-	-
15	-	3.7	3.7	-	-	-
15	-	3.8	3.8	-	-	-
16	4.3	-	4.3	4.2	0.19	4.5
16	4.1	-	4.1	-	-	-
16	-	4.3	4.3	-	-	-
16	-	3.9	3.9	-	-	-

TABLE 69. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "E" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
17	4.5	-	4.5	4.6	0.07	1.5
17	-	4.6	4.6	-	-	-
18	5.2	-	5.2	5.4	0.28	5.2
18	-	5.6	5.6	-	-	-
19	6.2	-	6.2	6.2	0.00	0.0
19	-	6.2	6.2	-	-	-
20	7.8	-	7.8	8.0	0.21	2.6
20	-	8.1	8.1	-	-	-
21	13.6	-	13.6	14.3	0.99	6.9
21	-	15.0	15.0	-	-	-
22	22.0	-	22.0	23.0	1.34	5.8
22	-	23.9	23.9	-	-	-
23	30.4	-	30.4	31.4	1.41	4.5
23	-	32.4	32.4	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-19 hours):		
Y = 0.29716*X -0.42530	0.965	Reactor-A
Y = 0.30184*X -0.48695	0.953	Reactor-B
Y = 0.29950*X -0.45614	0.959	Combined Data
Y = 0.30290*X -0.42354	0.968	Average Data
Post-Induction Period (20-23 hours):		
Y = 7.6200*X -145.38	0.993	Reactor-A
Y = 8.1800*X -156.02	0.997	Reactor-B
Y = 7.9000*X -150.70	0.988	Combined Data
Y = 7.8900*X -150.46	0.995	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 70. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "F"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	1.0	-	1.0	0.9	0.00	0.0
2	-	0.7	0.7	-	-	-
3	2.5	-	2.5	2.5	0.07	2.8
3	-	2.4	2.4	-	-	-
4	3.7	-	3.7	3.8	0.07	1.8
4	-	3.8	3.8	-	-	-
5	5.5	-	5.5	5.8	0.35	6.0
5	6.1	-	6.1	-	-	-
5	-	5.5	5.5	-	-	-
5	-	6.1	6.1	-	-	-
6	7.6	-	7.6	8.3	0.79	9.5
6	8.8	-	8.8	-	-	-
6	-	7.6	7.6	-	-	-
6	-	9.1	9.1	-	-	-
7	13.2	-	13.2	15.8	2.52	15.9
7	18.2	-	18.2	-	-	-
7	-	14.1	14.1	-	-	-
7	-	17.7	17.7	-	-	-
8	26.0	-	26.0	28.6	2.55	8.9
8	31.1	-	31.1	-	-	-
8	-	26.8	26.8	-	-	-
8	-	30.4	30.4	-	-	-
9	47.6	-	47.6	48.0	0.49	1.0
9	-	48.3	48.3	-	-	-
10	59.0	-	59.0	59.3	0.35	0.6
10	-	59.5	59.5	-	-	-

TABLE 70. Oxidation of Fuel No. 18496 at 120°C Containing 17 mg/L of Antioxidant "F" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-6 hours):		
Y = 1.4532*X -1.2558	0.939	Reactor-A
Y = 1.4872*X -1.3767	0.929	Reactor-B
Y = 1.4702*X -1.3163	0.934	Combined Data
Y = 1.4071*X -1.1786	0.936	Average Data
Post-Induction Period (6-10 hours):		
Y = 13.024*X -72.873	0.965	Reactor-A
Y = 13.129*X -73.420	0.968	Reactor-B
Y = 13.077*X -73.146	0.966	Combined Data
Y = 13.420*X -75.360	0.980	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 71. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "G"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
1	1.1	-	1.1	1.1	0.07	6.4
1	-	1.0	1.0	-	-	-
2	1.2	-	1.2	1.2	0.00	0.0
2	-	1.2	1.2	-	-	-
3	1.7	-	1.7	1.5	0.35	23.3
3	-	1.2	1.2	-	-	-
4	1.9	-	1.9	1.8	0.21	11.7
4	-	1.6	1.6	-	-	-
5	2.1	-	2.1	2.2	0.07	3.2
5	-	2.2	2.2	-	-	-
6	2.4	-	2.4	2.5	0.07	2.8
6	-	2.5	2.5	-	-	-
7	3.0	-	3.0	2.7	0.38	14.1
7	2.4	-	2.4	-	-	-
7	-	3.0	3.0	-	-	-
7	-	2.3	2.3	-	-	-
8	2.6	-	2.6	2.7	0.19	7.0
8	2.7	-	2.7	-	-	-
8	-	3.0	3.0	-	-	-
8	-	2.6	2.6	-	-	-
9	3.0	-	3.0	2.9	0.32	11.0
9	2.6	-	2.6	-	-	-
9	-	3.3	3.3	-	-	-
9	-	2.7	2.7	-	-	-
10	3.1	-	3.1	3.1	0.07	2.3
10	-	3.0	3.0	-	-	-
11	3.3	-	3.3	3.5	0.28	8.0
11	-	3.7	3.7	-	-	-
12	3.8	-	3.8	3.9	0.07	1.8
12	-	3.9	3.9	-	-	-
13	4.5	-	4.5	4.6	0.14	3.0
13	-	4.7	4.7	-	-	-
14	4.9	-	4.9	5.6	0.62	11.1
14	5.8	-	5.8	-	-	-
14	-	5.2	5.2	-	-	-
14	-	6.3	6.3	-	-	-
15	5.9	-	5.9	7.1	1.18	16.6
15	8.6	-	8.6	-	-	-
15	-	6.4	6.4	-	-	-
15	-	7.3	7.3	-	-	-

TABLE 71. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "G" (Cont'd)

Stress	(Peroxides, ppm)$^{1/2}$					
Time, hr	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
16	13.7	-	13.7	15.9	3.04	19.1
16	-	18.0	18.0	-	-	-
17	23.2	-	23.2	25.3	2.97	11.7
17	-	27.4	27.4	-	-	-
18	31.5	-	31.5	33.7	3.04	9.0
18	-	35.8	35.8	-	-	-
19	40.0	-	40.0	41.6	2.19	5.3
19	-	43.1	43.1	-	-	-
20	46.6	-	46.6	48.6	2.76	5.7
20	-	50.5	50.5	-	-	-
21	52.1	-	52.1	54.0	2.69	5.0
21	-	55.9	55.9	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-15 hours):		
Y = 0.37927*X +0.03267	0.823	Reactor-A
Y = 0.38653*X +0.02652	0.883	Reactor-B
Y = 0.38287*X +0.02995	0.850	Combined Data
Y = 0.35529*X +0.23529	0.901	Average Data
Post-Induction Period (15-21 hours):		
Y = 7.76306*X -109.1	0.994	Reactor-A
Y = 8.33311*X -116.3	0.990	Reactor-B
Y = 8.04809*X -112.7	0.984	Combined Data
Y = 7.94286*X -110.7	0.994	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 72. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "H"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.0	-	0.0	0.0	0.00	0.0
0	-	0.0	0.0	-	-	-
1	0.0	-	0.0	0.0	0.00	0.0
1	-	0.0	0.0	-	-	-
2	0.0	-	0.0	0.0	0.00	0.0
2	-	0.0	0.0	-	-	-
3	0.0	-	0.0	0.0	0.00	0.0
3	-	0.0	0.0	-	-	-
4	0.7	-	0.7	0.7	0.00	0.0
4	-	0.7	0.7	-	-	-
5	1.0	-	1.0	1.0	0.00	0.0
5	-	1.0	1.0	-	-	-
6	1.0	-	1.0	-	0.00	0.0
6	-	1.0	1.0	-	-	-
7	1.2	-	1.2	1.4	0.16	11.4
7	1.6	-	1.6	-	-	-
7	-	1.4	1.4	-	-	-
7	-	1.4	1.4	-	-	-
8	1.7	-	1.7	1.5	0.24	16.0
8	1.2	-	1.2	-	-	-
8	-	1.5	1.5	-	-	-
8	-	1.7	1.7	-	-	-
9	1.6	-	1.6	1.7	0.17	10.0
9	1.9	-	1.9	-	-	-
9	-	1.8	1.8	-	-	-
9	-	1.9	1.9	-	-	-
10	2.0	-	2.0	2.1	0.07	3.3
10	-	2.1	2.1	-	-	-
11	2.2	-	2.2	2.3	0.14	6.1
11	-	2.4	2.4	-	-	-
12	2.7	-	2.7	2.7	0.07	2.6
12	-	2.6	2.6	-	-	-
13	2.9	-	2.9	2.8	0.14	5.0
13	-	2.7	2.7	-	-	-
14	3.0	-	3.0	2.9	0.17	5.9
14	2.9	-	2.9	-	-	-
14	-	3.1	3.1	-	-	-
14	-	2.7	2.7	-	-	-
15	3.5	-	3.5	3.5	0.29	8.3
15	3.1	-	3.1	-	-	-
15	-	3.8	3.8	-	-	-
15	-	3.6	3.6	-	-	-
16	3.6	-	3.6	3.8	0.21	5.5
16	3.6	-	3.6	-	-	-
16	-	4.0	4.0	-	-	-
16	-	3.9	3.9	-	-	-

TABLE 72. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "H" (Cont'd)

Stress Time, hr	$(\text{Peroxides, ppm})^{1/2}$					
	Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
17	4.4	-	4.4	4.5	0.07	1.6
17	-	4.5	4.5	-	-	-
18	5.1	-	5.1	5.2	0.14	2.7
18	-	5.3	5.3	-	-	-
19	6.2	-	6.2	6.7	0.71	10.6
19	-	7.2	7.2	-	-	-
20	8.9	-	8.9	10.5	2.19	20.9
20	-	12.0	12.0	-	-	-
21	17.0	-	17.0	19.9	4.03	20.3
21	-	22.7	22.7	-	-	-
22	26.2	-	26.2	28.9	3.75	13.0
22	-	31.5	31.5	-	-	-
23	35.4	-	35.4	37.6	3.11	8.3
23	-	39.8	39.8	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-19 hours):		
Y = 0.28227*X -0.61568	0.931	Reactor-A
Y = 0.30569*X -0.72592	0.906	Reactor-B
Y = 0.29398*X -0.67080	0.915	Combined Data
Y = 0.30182*X -0.67022	0.924	Average Data
Post-Induction Period (19-23 hours):		
Y = 7.5700*X -140.2	0.971	Reactor-A
Y = 8.4700*X -155.2	0.990	Reactor-B
Y = 8.0200*X -147.7	0.951	Combined Data
Y = 8.0200*X -147.7	0.984	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 73. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "I"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.0	-	1.0	1.3	0.42	32.3
0	-	1.6	1.6	-	-	-
1	1.5	-	1.5	1.3	0.32	24.6
1	-	1.0	1.0	-	-	-
2	1.5	-	1.5	1.5	0.00	0.0
2	-	1.5	1.5	-	-	-
3	1.9	-	1.9	1.9	0.00	0.0
3	-	1.9	1.9	-	-	-
4	2.6	-	2.6	2.5	0.21	8.4
4	-	2.3	2.3	-	-	-
5	2.9	-	2.9	2.8	0.14	5.0
5	-	2.7	2.7	?	-	-
6	3.4	-	3.4	3.5	0.07	2.0
6	-	3.5	3.5	-	-	-
7	4.3	-	4.3	4.0	0.44	11.0
7	3.7	-	3.7	-	-	-
7	-	4.5	4.5	-	-	-
7	-	3.6	3.6	-	-	-
8	5.7	-	5.7	5.0	0.62	12.4
8	4.6	-	4.6	-	-	-
8	-	5.4	5.4	-	-	-
8	-	4.4	4.4	-	-	-
9	7.5	-	7.5	6.5	1.10	16.9
9	5.5	-	5.5	-	-	-
9	-	7.3	7.3	-	-	-
9	-	5.5	5.5	-	-	-
10	7.4	-	7.4	7.2	0.28	3.9
10	-	7.0	7.0	-	-	-
11	10.4	-	10.4	10.0	0.64	6.4
11	-	9.5	9.5	-	-	-
12	18.8	-	18.8	18.1	0.99	5.5
12	-	17.4	17.4	-	-	-
13	28.1	-	28.1	26.9	1.77	6.6
13	-	25.6	25.6	-	-	-
14	36.0	-	36.0	35.0	1.48	4.2
14	-	33.9	33.9	-	-	-
15	42.9	-	42.9	43.3	0.57	1.3
15	-	43.7	43.7	-	-	-
16	50.8	-	50.8	50.5	0.42	0.8
16	-	50.2	50.2	-	-	-

TABLE 73. **Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "I" (Cont'd)**

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-11 hours):		
Y = 0.72438*X -0.08625	0.849	Reactor-A
Y = 0.67500*X +0.06333	0.858	Reactor-B
Y = 0.69969*X -0.01146	0.851	Combined Data
Y = 0.71503*X +0.02564	0.885	Average Data
Post-Induction Period (11-16 hours):		
Y = 8.06286*X -77.68	0.998	Reactor-A
Y = 8.30572*X -82.08	0.998	Reactor-B
Y = 8.18429*X -79.88	0.996	Combined Data
Y = 8.17714*X -79.76	0.999	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 74. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "J"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.5	0.85	56.7
0	-	2.1	2.1	-	-	-
1	1.7	-	1.7	1.7	0.00	0.0
1	-	1.7	1.7	-	-	-
2	2.1	-	2.1	2.2	0.07	3.2
2	-	2.2	2.2	-	-	-
3	2.5	-	2.5	2.7	0.21	7.8
3	-	2.8	2.8	-	-	-
4	3.4	-	3.4	3.4	0.07	2.1
4	-	3.3	3.3	-	-	-
5	3.8	-	3.8	4.0	0.21	5.3
5	-	4.1	4.1	-	-	-
6	4.8	-	4.8	4.7	0.14	3.0
6	-	4.6	4.6	-	-	-
7	5.6	-	5.6	5.1	0.64	12.5
7	4.4	-	4.4	-	-	-
7	-	5.6	5.6	-	-	-
7	-	4.6	4.6	-	-	-
8	7.2	-	7.2	6.2	0.92	14.8
8	5.6	-	5.6	-	-	-
8	-	6.8	6.8	-	-	-
8	-	5.3	5.3	-	-	-
9	6.6	-	6.6	6.6	0.07	1.1
9	-	6.5	6.5	-	-	-
10	8.4	-	8.4	8.4	0.00	0.0
10	-	8.4	8.4	-	-	-
11	13.3	-	13.3	13.2	0.14	1.1
11	-	13.3	13.3	-	-	-
12	21.1	-	21.1	20.7	0.64	3.1
12	-	20.2	20.2	-	-	-
13	29.2	-	29.2	29.6	0.57	1.9
13	-	30.0	30.0	-	-	-
14	38.2	-	38.2	38.2	0.00	0.0
14	-	39.2	38.2	-	-	-
15	45.4	-	45.4	45.8	0.57	1.2
15	-	46.2	46.2	-	-	-
16	50.6	-	50.6	50.6	0.07	0.1
16	-	50.5	50.5	-	-	-

TABLE 74. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "J" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-10 hours):		
Y = 0.6911*X +0.6633	0.940	Reactor-A
Y = 0.6128*X +1.1620	0.914	Reactor-B
Y = 0.6519*X +0.9126	0.925	Combined Data
Y = 0.6564*X +0.9455	0.969	Average Data
Post-Induction Period (10-16 hours):		
Y = 7.4250*X -67.07	0.995	Reactor-A
Y = 7.5036*X -68.00	0.992	Reactor-B
Y = 7.4643*X -67.54	0.993	Combined Data
Y = 7.4750*X -67.67	0.993	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 75. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "L"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.6	0.99	61.9
0	-	2.3	2.3	-	-	-
1	1.4	-	1.4	1.3	0.14	10.8
1	-	1.2	1.2	-	-	-
2	1.3	-	1.3	1.5	0.28	18.7
2	-	1.7	1.7	-	-	-
3	1.5	-	1.5	1.8	0.35	19.4
3	-	2.0	2.0	-	-	-
4	1.9	-	1.9	2.1	0.21	10.0
4	-	2.2	2.2	-	-	-
5	2.4	-	2.4	2.6	0.21	8.1
5	-	2.7	2.7	-	-	-
6	2.5	-	2.5	2.9	0.49	16.9
6	-	3.2	3.2	-	-	-
7	3.3	-	3.3	3.3	0.40	12.1
7	2.9	-	2.9	-	-	-
7	-	3.8	3.8	-	-	-
7	-	3.0	3.0	-	-	-
8	3.5	-	3.5	3.5	0.50	14.3
8	3.1	-	3.1	-	-	-
8	-	4.2	4.2	-	-	-
8	-	3.2	3.2	-	-	-
9	4.2	-	4.2	4.3	0.70	16.3
9	3.7	-	3.7	-	-	-
9	-	5.3	5.3	-	-	-
9	-	4.0	4.0	-	-	-
10	4.4	-	4.4	4.6	0.28	6.1
10	-	4.8	4.8	-	-	-
11	5.4	-	5.4	5.6	0.28	5.0
11	-	5.8	5.8	-	-	-
12	7.0	-	7.0	7.5	0.64	8.5
12	-	7.9	7.9	-	-	-
13	11.2	-	11.2	12.2	1.41	11.6
13	-	13.2	13.2	-	-	-
14	18.8	-	18.5	20.2	2.33	11.5
14	-	21.8	21.8	-	-	-
15	28.0	-	28.0	29.9	2.69	9.0
15	-	31.8	31.8	-	-	-
16	36.2	-	36.2	38.2	2.83	7.4
16	-	40.2	40.2	-	-	-
17	42.8	-	42.8	45.1	3.25	7.2
17	-	47.4	47.4	-	-	-

TABLE 75. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "L" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-11 hours):		
Y = 0.3713*X +0.5992	0.939	Reactor-A
Y = 0.3625*X +1.1183	0.828	Reactor-B
Y = 0.3669*X +0.8588	0.853	Combined Data
Y = 0.3696*X +0.8923	0.939	Average Data
Post-Induction Period (12-17 hours):		
Y = 7.5200*X -85.04	0.991	Reactor-A
Y = 8.2429*X -92.47	0.994	Reactor-B
Y = 7.8857*X -88.84	0.978	Combined Data
Y = 7.8771*X -88.70	0.993	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 76. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "M"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	1.4	-	1.4	1.0	0.44	44.0
0	0.8	-	0.8	-	-	-
0	-	1.2	1.2	-	-	-
0	-	0.4	0.4	-	-	-
1	1.5	-	1.5	1.1	0.33	30.0
1	0.8	-	0.8	-	-	-
1	-	1.3	1.3	-	-	-
1	-	0.9	0.9	-	-	-
2	1.4	-	1.4	1.2	0.21	17.5
2	1.0	-	1.0	-	-	-
2	-	1.4	1.4	-	-	-
2	-	1.1	1.1	-	-	-
3	1.6	-	1.6	1.6	0.17	10.6
3	1.3	-	1.3	-	-	-
3	-	1.7	1.7	-	-	-
3	-	1.6	1.6	-	-	-
4	2.1	-	2.1	1.8	0.26	14.4
4	1.6	-	1.6	-	-	-
4	-	2.0	2.0	-	-	-
4	-	1.6	1.6	-	-	-
5	2.3	-	2.3	2.3	0.17	7.4
5	2.0	-	2.0	-	-	-
5	-	2.4	2.4	-	-	-
5	-	2.3	2.3	-	-	-
6	2.7	-	2.7	2.5	0.28	11.2
6	2.2	-	2.2	-	-	-
6	-	2.8	2.8	-	-	-
6	-	2.4	2.4	-	-	-
7	3.2	-	3.2	3.1	0.37	11.9
7	2.8	-	2.8	-	-	-
7	-	3.5	3.5	-	-	-
7	-	2.7	2.7	-	-	-
8	3.7	-	3.7	3.7	0.74	20.0
8	3.0	-	3.0	-	-	-
8	-	4.7	4.7	-	-	-
8	-	3.3	3.3	-	-	-
9	3.5	-	3.5	3.7	0.28	7.6
9	-	3.9	3.9	-	-	-
10	4.1	-	4.1	4.2	0.07	1.7
10	-	4.2	4.2	-	-	-
11	5.0	-	5.0	5.2	0.21	4.0
11	-	5.3	5.3	-	-	-

TABLE 76. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "M" (Cont'd)

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
12	6.2	-	6.2	6.7	0.71	10.6
12	-	7.2	7.2	-	-	-
13	13.4	-	13.4	14.5	1.48	10.2
13	-	15.5	15.5	-	-	-
14.5	25.5	-	25.5	26.6	1.56	5.9
14.5	-	27.7	27.7	-	-	-
15	31.5	-	31.5	32.3	1.13	3.5
15	-	33.1	33.1	-	-	-
16	40.0	-	40.0	41.0	1.41	3.4
16	-	42.0	42.0	-	-	-
17	47.7	-	47.7	48.9	1.70	3.5
17	-	50.1	50.1	-	-	-

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-12 hours):		
Y = 0.3728*X +0.5319	0.896	Reactor-A
Y = 0.4382*X +0.3610	0.889	Reactor-B
Y = 0.4094*X +0.4520	0.890	Combined Data
Y = 0.4264*X +0.3725	0.922	Average Data
Post-Induction Period (12-17 hours):		
Y = 8.4673*X -96.10	0.998	Reactor-A
Y = 8.6538*X -96.93	0.999	Reactor-B
Y = 8.5605*X -96.52	0.994	Combined Data
Y = 8.5559*X -96.44	0.999	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 77. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "N"

Stress Time, hr	(Peroxides, ppm)$^{1/2}$ Reactor-A	Reactor-B	Reactors A&B	Average	St. Dev.	C. Var.
0	0.9	-	0.9	1.4	0.79	56.4
0	-	1.9	1.9	-	-	-
1	1.4	-	1.4	1.4	0.07	5.0
1	-	1.3	1.3	-	-	-
2	1.7	-	1.7	1.7	0.00	0.0
2	-	1.7	1.7	-	-	-
3	2.0	-	2.0	2.1	0.07	3.3
3	-	2.1	2.1	-	-	-
4	2.3	-	2.3	2.4	0.21	8.8
4	-	2.1	2.1	-	-	-
5	2.8	-	2.8	2.8	0.00	0.0
5	-	2.8	2.8	-	-	-
6	3.1	-	3.1	3.2	0.07	2.2
6	-	3.2	3.2	-	-	-
7	3.6	-	3.6	3.5	0.15	4.3
7	3.3	-	3.3	-	-	-
7	-	3.6	3.6	-	-	-
7	-	3.6	3.6	-	-	-
8	4.2	-	4.2	4.1	0.44	10.7
8	3.6	-	3.6	-	-	-
8	-	4.6	4.6	-	-	-
8	-	3.8	3.8	-	-	-
9	5.2	-	5.2	5.0	0.68	13.6
9	4.4	-	4.4	-	-	-
9	-	5.8	5.8	-	-	-
9	-	4.4	4.4	-	-	-
10	5.1	-	5.1	5.4	0.35	6.5
10	-	5.6	5.6	-	-	-
11	6.5	-	6.5	7.0	0.71	10.1
11	-	7.5	7.5	-	-	-
12	10.4	-	10.4	11.8	1.98	16.8
12	-	13.2	13.2	-	-	-
13	19.3	-	19.3	21.6	3.18	14.7
13	-	23.8	23.8	-	-	-
14	29.0	-	29.0	31.4	3.32	10.6
14	-	33.7	33.7	-	-	-
15	37.2	-	37.2	39.6	3.32	8.4
15	-	41.9	41.9	-	-	-
16	44.3	-	44.3	47.4	4.31	9.1
16	-	50.4	50.4	-	-	-

TABLE 77. Oxidation of Fuel No. 18497 at 120°C Containing 17 mg/L of Antioxidant "N" (Cont'd)

Linear Regression Analysis of the Data

Equations	R^2	Source
Induction Period (0-11 hours):		
Y = 0.4475*X +0.6550	0.938	Reactor-A
Y = 0.4781*X +0.7313	0.854	Reactor-B
Y = 0.4628*X +0.8844	0.884	Combined Data
Y = 0.4699*X +0.7487	0.930	Average Data
Post-Induction Period (11-16 hours):		
Y = 7.9743*X -83.20	0.991	Reactor-A
Y = 8.8714*X -91.35	0.996	Reactor-B
Y = 8.4229*X -87.28	0.972	Combined Data
Y = 8.4343*X -87.40	0.994	Average Data

Notes:

St. Dev. = Standard deviation of all data.
C. Var. = Coefficient of variation or relative standard deviation.
R^2 = Coefficient of determination.

TABLE 78. Effect of Antioxidants on the Oxidation of Turbine Fuels at 100°C

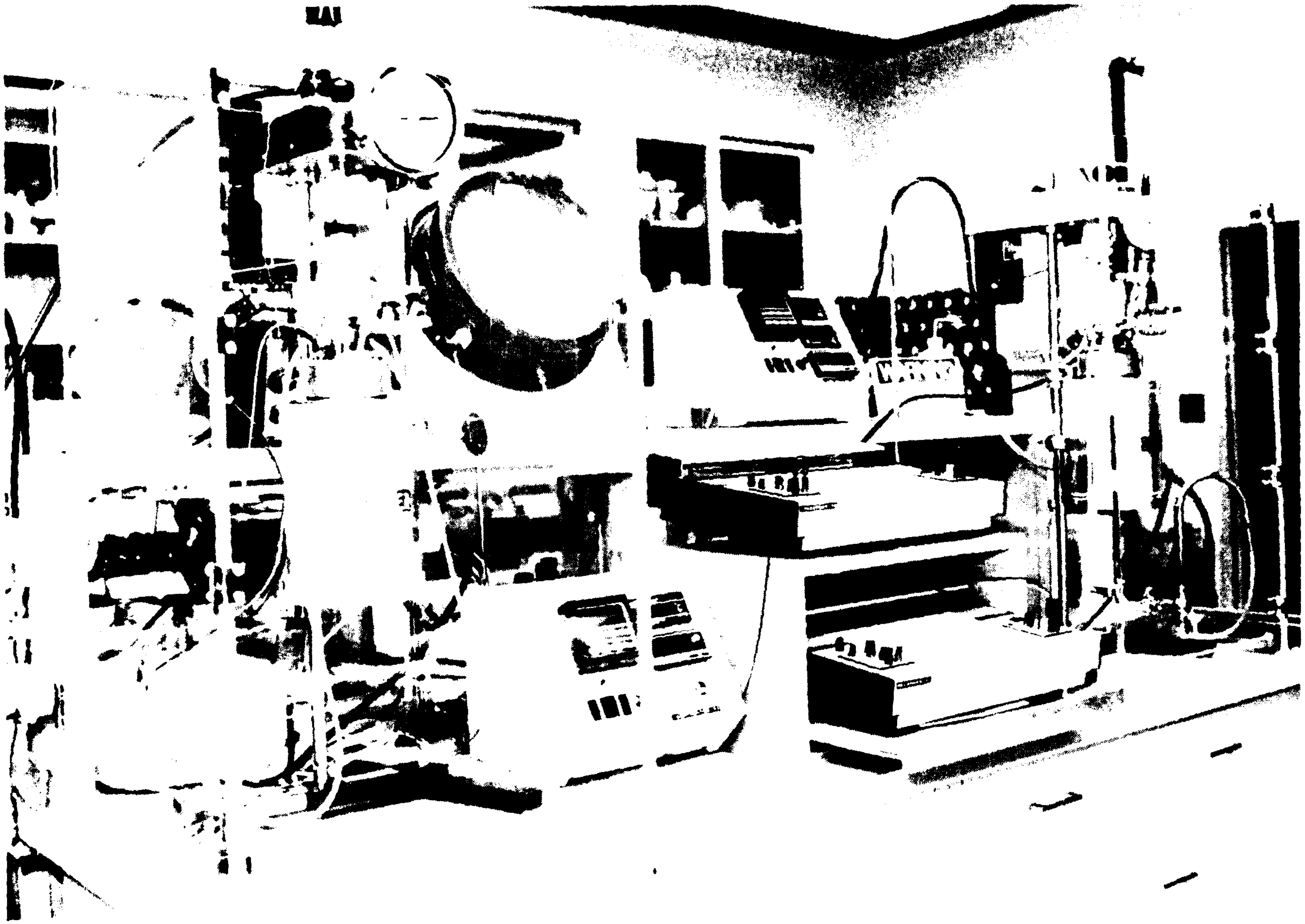
			Induction Period (IP)			Post-Induction Period (Linear Part)			Calculated Induction	Relative IP
Fuel No.	AO-ID	Filename	Hours	Equation (Average)	R^2	Max hr	Equation (Average)	R^2	Period, hr	Increase, hr
18496	-0-	AO2\PER01A	20	Y = 0.3520*X +0.320	0.960	40	Y = 2.9280*X -51.20	0.985	20.0	1.00
18496	A	AO2\PER03A	55	Y = 0.1183*X -0.144	0.959	70	Y = 3.3040*X -174.2	0.999	54.6	2.73
18496	B	AO2\PER05A	45	Y = 0.2352*X -0.451	0.872	65	Y = 2.7660*X -109.9	0.959	43.2	2.16
18496	C	AO2\PER07A	40	Y = 0.2013*X -0.104	0.975	55	Y = 3.0700*X -115.2	0.982	40.1	2.01
18496	-0-	AO2\PER01A	20	Y = 0.3520*X +0.320	0.960	40	Y = 2.9280*X -51.20	0.985	20.0	1.00
18496	D	AO2\PER09A	35	Y = 0.1871*X +0.307	0.957	50	Y = 2.6120*X -83.76	0.967	34.7	1.74
18496	E	AO2\PER10A	40	Y = 0.1909*X -0.308	0.920	55	Y = 2.4280*X -90.98	0.964	40.5	2.03
18496	F	AO2\PER11A	40	Y = 0.1500*X +0.700	0.944	55	Y = 3.2980*X -123.5	0.969	39.5	1.98
18496	G	AO2\PER12A	35	Y = 0.1571*X +0.743	0.939	55	Y = 2.4600*X -77.14	0.951	33.8	1.69
18496	H	AO2\PER13A	48	Y = 0.1567*X +0.011	0.868	60	Y = 4.9300*X -229.5	0.961	48.1	2.41
18496	I	AO2\PER14A	30	Y = 0.2887*X -0.001	0.927	50	Y = 2.6479*X -67.05	0.991	28.4	1.42
18496	J	AO2\PER15A	35	Y = 0.4136*X -1.075	0.901	50	Y = 2.9300*X -82.25	0.929	32.3	1.61
18496	L	AO2\PER16A	29	Y = 0.2703*X -0.029	0.920	45	Y = 3.1820*X -83.80	0.973	28.4	1.42
18496	M	AO2\PER17A	30	Y = 0.2129*X +0.607	0.948	50	Y = 2.7160*X -73.98	0.987	29.8	1.49
18496	N	AO2\PER18A	33	Y = 0.2117*X +0.747	0.987	50	Y = 4.2159*X -132.6	0.998	32.9	1.65
18497	-0-	AO2\PER02A	15	Y = 0.2880*X +0.440	0.909	40	Y = 1.2800*X -14.70	0.988	15.3	1.00
18497	A	AO2\PER04A	95	Y = 0.0338*X +1.233	0.913	135	Y = 1.1125*X -103.1	0.982	96.7	6.32
18497	B	AO2\PER06A	100	Y = 0.0298*X +0.695	0.825	150	Y = 0.7412*X -71.88	0.956	102.0	6.67
18497	C	AO2\PER08A	105	Y = 0.0267*X +0.869	0.706	160	Y = 0.8815*X -89.15	0.983	105.3	6.88
18497	-0-	AO2\PER19A	20	Y = 0.2820*X +0.520	0.923	40	Y = 1.5760*X -25.22	0.974	19.9	1.00
18497	D	AO2\PER20A	90	Y = 0.0486*X -0.364	0.900	140	Y = 0.8478*X -69.02	0.933	85.9	4.32
18497	E	AO2\PER21A	110	Y = 0.0449*X +0.815	0.788	150	Y = 1.0213*X -106.4	0.981	109.8	5.52
18497	F	AO2\PER22A	100	Y = 0.0329*X +1.166	0.822	155	Y = 0.7646*X -71.86	0.896	99.8	5.02
18497	G	AO2\PER23A	80	Y = 0.0548*X +1.614	0.943	135	Y = 0.8621*X -61.84	0.946	78.6	3.95
18497	H	AO2\PER24A	115	Y = 0.0332*X +0.844	0.799	145	Y = 1.0050*X -111.1	0.835	115.2	5.79
18497	I	AO2\PER25A	60	Y = 0.0979*X +1.210	0.975	95	Y = 0.9961*X -52.57	0.993	59.9	3.01
18497	J	AO2\PER26A	55	Y = 0.0953*X +1.042	0.932	110	Y = 0.7788*X -35.61	0.956	53.6	2.69
18497	L	AO2\PER27A	55	Y = 0.1088*X -0.329	0.934	100	Y = 0.8481*X -41.75	0.969	56.0	2.81
18497	M	AO2\PER28A	65	Y = 0.0646*X +1.015	0.917	100	Y = 1.1255*X -67.39	0.962	64.5	3.24
18497	N	AO2\PER29A	55	Y = 0.0740*X +1.534	0.966	100	Y = 1.0399*X -51.45	0.991	54.9	2.76

TABLE 79. Effect of Antioxidants on the Oxidation of Turbine Fuels at 120°C

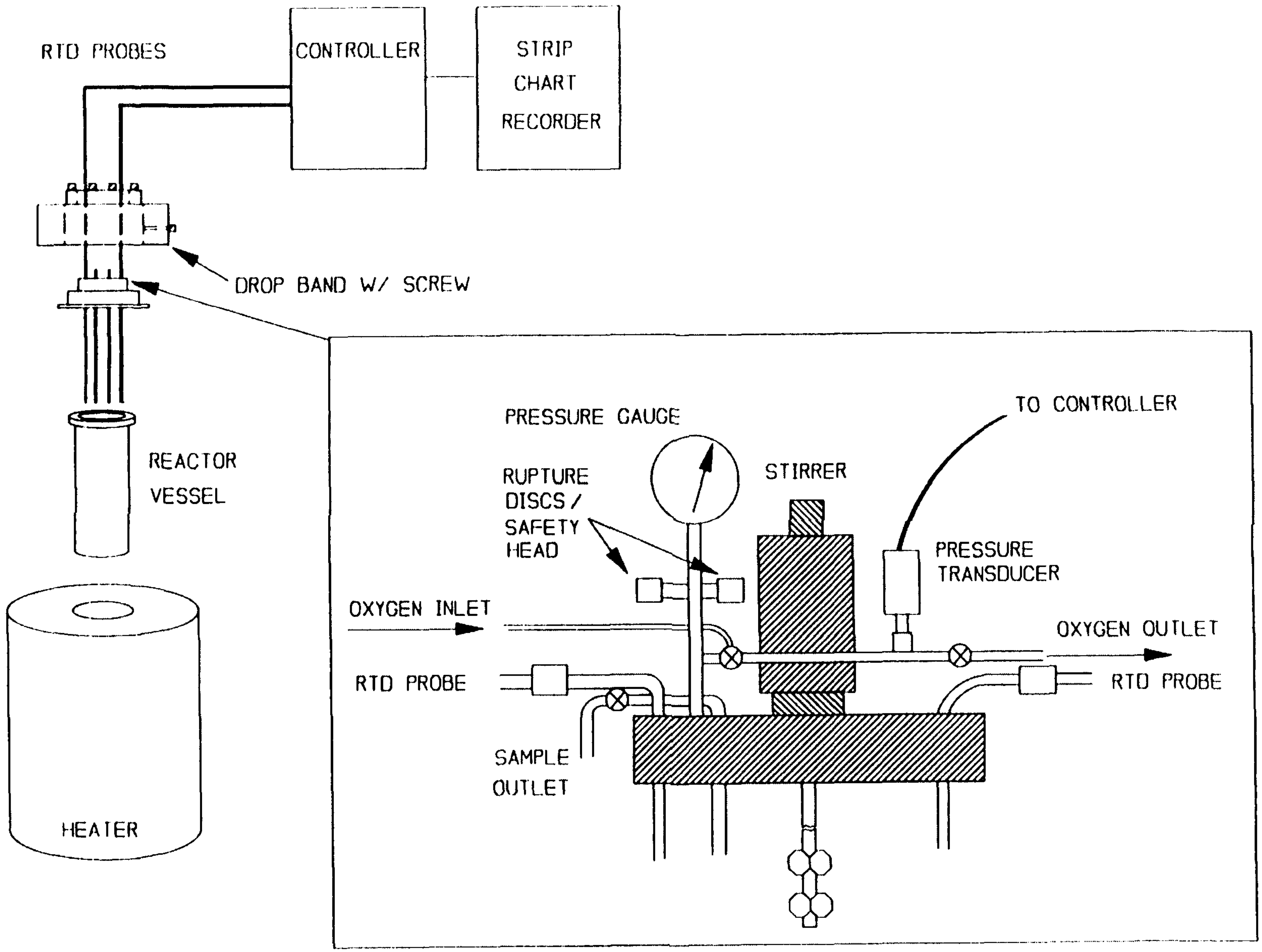
			Induction Period (IP)			Post-Induction Period (Linear Part)			Calculated Induction	Relative IP
Fuel No.	AO-ID	Filename	Hours	Equation (Average)	R^2	Max hr	Equation (Average)	R^2	Period, hr	Increase, hr
18496	-0-	AO1\PER24A	4.0	Y = 2.5900*X -1.3000	0.898	8	Y = 13.010*X -42.16	0.997	3.9	1.00
18496	A	AO1\PER30A	8.0	Y = 0.8250*X -0.0222	0.956	13	Y = 10.277*X -77.23	0.986	8.2	2.10
18496	B	AO1\PER32A	6.0	Y = 1.1929*X -0.9786	0.923	11	Y = 11.423*X -65.26	0.979	6.3	1.62
18496	C	AO1\PER34A	6.0	Y = 1.5893*X -1.1964	0.914	9	Y = 13.180*X -72.15	0.960	6.1	1.56
18496	D	AO1\PER36A	6.0	Y = 1.3829*X -0.6571	0.971	9	Y = 14.110*X -75.45	0.990	5.9	1.51
18496	E	AO1\PER38A	6.5	Y = 1.3357*X -0.9357	0.957	11	Y = 14.390*X -87.27	0.994	6.6	1.69
18496	F	AO1\PER40A	6.0	Y = 1.4071*X -1.1786	0.936	10	Y = 13.420*X -75.36	0.980	6.2	1.59
18496	G	AO1\PER42A	6.0	Y = 1.7893*X -0.9964	0.930	10	Y = 11.880*X -58.84	0.986	5.7	1.46
18496	H	AO1\PER44A	6.7	Y = 1.0179*X +0.5036	0.933	10	Y = 13.660*X -84.86	0.989	6.8	1.74
18496	I	AO1\PER46A	4.7	Y = 1.8000*X +0.4800	0.945	8	Y = 15.060*X -60.84	0.993	4.6	1.18
18496	J	AO1\PER48A	4.8	Y = 1.6100*X +0.8000	0.933	9	Y = 13.950*X -58.47	0.991	4.8	1.23
18496	L	AO1\PER50A	5.0	Y = 1.3500*X +0.6200	0.948	9	Y = 13.790*X -60.59	0.988	4.9	1.26
18496	M	AO1\PER52A	5.0	Y = 1.5886*X +0.5286	0.917	9	Y = 14.380*X -64.16	0.989	5.1	1.31
18496	N	AO1\PER54A	4.9	Y = 1.3500*X +0.9200	0.966	9	Y = 13.620*X -59.10	0.987	4.9	1.26
18497	-0-	AO1\PER25A	2.0	Y = 1.5500*X +1.1500	0.973	8	Y = 8.6179*X -14.15	0.993	2.2	1.00
18497	A	AO1\PER31A	17.0	Y = 0.3568*X -0.8269	0.956	23	Y = 7.8750*X -132.2	0.976	17.5	7.95
18497	B	AO1\PER33A	20.0	Y = 0.2674*X -0.4359	0.961	25	Y = 7.0486*X -138.1	0.974	20.3	9.23
18497	C	AO1\PER35A	15.0	Y = 0.4046*X -0.4392	0.982	20	Y = 8.5457*X -120.9	0.998	14.8	6.73
18497	D	AO1\PER37A	14.5	Y = 0.3946*X -0.3758	0.961	20	Y = 8.0714*X -112.3	0.997	14.7	6.68
18497	E	AO1\PER39A	20.0	Y = 0.3029*X -0.4235	0.968	23	Y = 7.8900*X -150.5	0.995	19.8	9.00
18497	F	AO1\PER41A	18.0	Y = 0.3072*X -0.8963	0.936	23	Y = 7.2829*X -128.2	0.980	18.2	8.27
18497	G	AO1\PER43A	15.0	Y = 0.3553*X +0.2353	0.901	21	Y = 7.9429*X -110.7	0.994	14.6	6.64
18497	H	AO1\PER45A	19.0	Y = 0.3018*X -0.6702	0.924	23	Y = 8.0200*X -147.7	0.984	19.0	8.64
18497	I	AO1\PER47A	11.0	Y = 0.7150*X +0.0256	0.885	16	Y = 8.1771*X -79.76	0.999	10.7	4.86
18497	J	AO1\PER49A	10.0	Y = 0.6564*X +0.9455	0.969	16	Y = 7.4750*X -67.67	0.993	10.1	4.59
18497	L	AO1\PER51A	12.0	Y = 0.3696*X +0.8923	0.939	17	Y = 7.8771*X -88.70	0.993	11.9	5.41
18497	M	AO1\PER53A	12.0	Y = 0.4264*X +0.3725	0.922	17	Y = 8.5559*X -96.44	0.999	11.9	5.41
18497	N	AO1\PER55A	11.0	Y = 0.4699*X +0.7487	0.930	16	Y = 8.4343*X -87.40	0.994	11.1	5.05

APPENDIX

Technical Data of Pressure Reactors



Photograph of 600-mL, Type 316 stainless steel stirred pressure reactors



Schematic of PARR Reactors